WASHINGTON STATE
DEPARTMENT OF
ECOLOGY

Colville River Fecal Coliform Total Maximum Daily Load Study

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Colville River Fecal Coliform Total Maximum Daily Load Study

by
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July 2002

Waterbody Numbers: See Table 2

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Abstract

Previous sampling of the Colville River has found bacteria violations of the state water quality standards during the summer months. In response to these impairments, the Washington State Department of Ecology conducted a total maximum daily load study for fecal coliform in the Colville River basin from March 2000 through March 2001. A total of 10 mainstem and 15 tributary and headwater sites were sampled every other week. Discharge during the study averaged 27% above normal.

Study results showed violations of the state bacteria standards were widespread through the dry season. Only the Sheep Creek site in Springdale, a headwater stream flowing from the uplands, and the most downstream site, the Colville River at Greenwood Loop Road, were without bacteria violations. The critical period for loading was between June and September, with the exception of Blue Creek. Blue Creek, a small tributary discharging to the Colville River at river mile 37, had the highest bacteria counts for the study. Work is underway to connect the community of Bluecreek to the newly constructed wastewater treatment facility in Addy in late 2002.

To determine reduction targets needed for compliance with water quality standards, rolling geometric means and 90th percentiles for bacteria counts were calculated for two- and three-month periods. The "statistical theory of rollback" was applied to determine the percentage of reduction in bacteria loads that would be needed during the critical period per river segment to bring water quality within standards. The percentage of load reductions needed per sub-basin ranged from 3% to 95%.

Acknowledgements

Thanks are extended to all the people who contributed valuable time and energy to the success of this project. The study would not have been possible without their help.

Stevens County Conservation District:

- Charlie Kessler provided support for the study, management skills, a wealth of basin knowledge, and review comments for the quality assurance project plan and final report.
- Enduring the weather and a challenging time schedule, Tom Ledgerwood conducted sampling and flow measurements for an entire year.

Washington State Department of Ecology:

- Greg Pelletier, project manager, was responsible for study design and review of the quality assurance project plan and final report.
- Nancy Jensen, Manchester Environmental Laboratory, performed the bacteria analysis throughout the study.
- Pam Covey, Manchester Environmental Laboratory, accepted and organized samples for analysis.
- Will White provided sample collection bottles and transferred samples to Manchester Environmental Laboratory.
- Dale Norton offered valuable review comments on the quality assurance project plan and final report.
- Karol Erickson offered valuable review comments on the quality assurance project plan.
- John Summers VII installed flow monitoring equipment.
- Paul Anderson and Dennis Murray assisted in the field during synoptic surveys and flow studies.
- Joan LeTourneau formatted and edited the final report.

Introduction

In response to Section 303(d) of the 1972 federal Clean Water Act, the Washington State Department of Ecology (Ecology) has included portions of the Colville River and tributaries on the list of waterbodies not meeting water quality standards for fecal coliform (FC) bacteria. Past and recent studies have found water quality impairment throughout the Colville River basin from bacteria. The purpose of this report is to establish a total maximum daily load (TMDL) for FC bacteria to address the excess loading.

A TMDL is a plan to help attain water quality standards by determining the allowable pollutant load a stream may receive. Section 303(d) requires Ecology to implement water-quality-based pollution controls on streams where technology-based controls are inadequate to achieve water quality standards. To meet the requirements of Section 303(d) on the Colville River, a TMDL must be established for pollutants violating water quality standards.

Developing and applying the water-quality-based approach to water quality management entails a five-step process which includes: 1) problem identification; 2) technical analysis to determine the loading capacity of the waterbody to assimilate the pollutant; 3) establishment of allocations of pollutant loads; 4) public participation; and 5) an implementation plan for the TMDL. This study addresses the problem identification, loading capacity, and load allocation elements of the TMDL process.

Setting

Located in northeastern Washington State, the Colville River basin lies within the Selkirk Mountains between the Pend Oreille and Columbia rivers. The Colville watershed is about 50 miles long and 25 miles wide, with a north to south orientation. Basin elevations range from 1,290 feet around the river mouth to 6,700 feet near Calispell Peak. Headwater streams start in the area 19 miles north of Spokane, while discharge is about 30 miles from the Canadian border.

The Colville River begins at the confluence of Sheep Creek and Deer Creek in southern Stevens County, and meanders northerly for about 60 river miles. Along its course the river passes through the cities of Chewelah and Colville, eventually discharging near the town of Kettle Falls to Franklin D. Roosevelt Lake, an impoundment of the Columbia River behind Grand Coulee Dam (Figure 1). The Colville River watershed accounts for an entire Water Resource Inventory Area (WRIA 59).

The Colville River drains a 1,016 square mile area, with all but about eight square miles of the basin contained within Stevens County. The portion outside Stevens County is the headwater area of the Little Pend Oreille River drainage, along the northeastern divide, in Pend Oreille County to the east. The Colville River drains 41% of the land area in Stevens County. Ranking 23rd in population of the 39 Washington counties, rural Stevens County has 40,066 residents, based on the 2000 Federal Census (OFM, 2002).

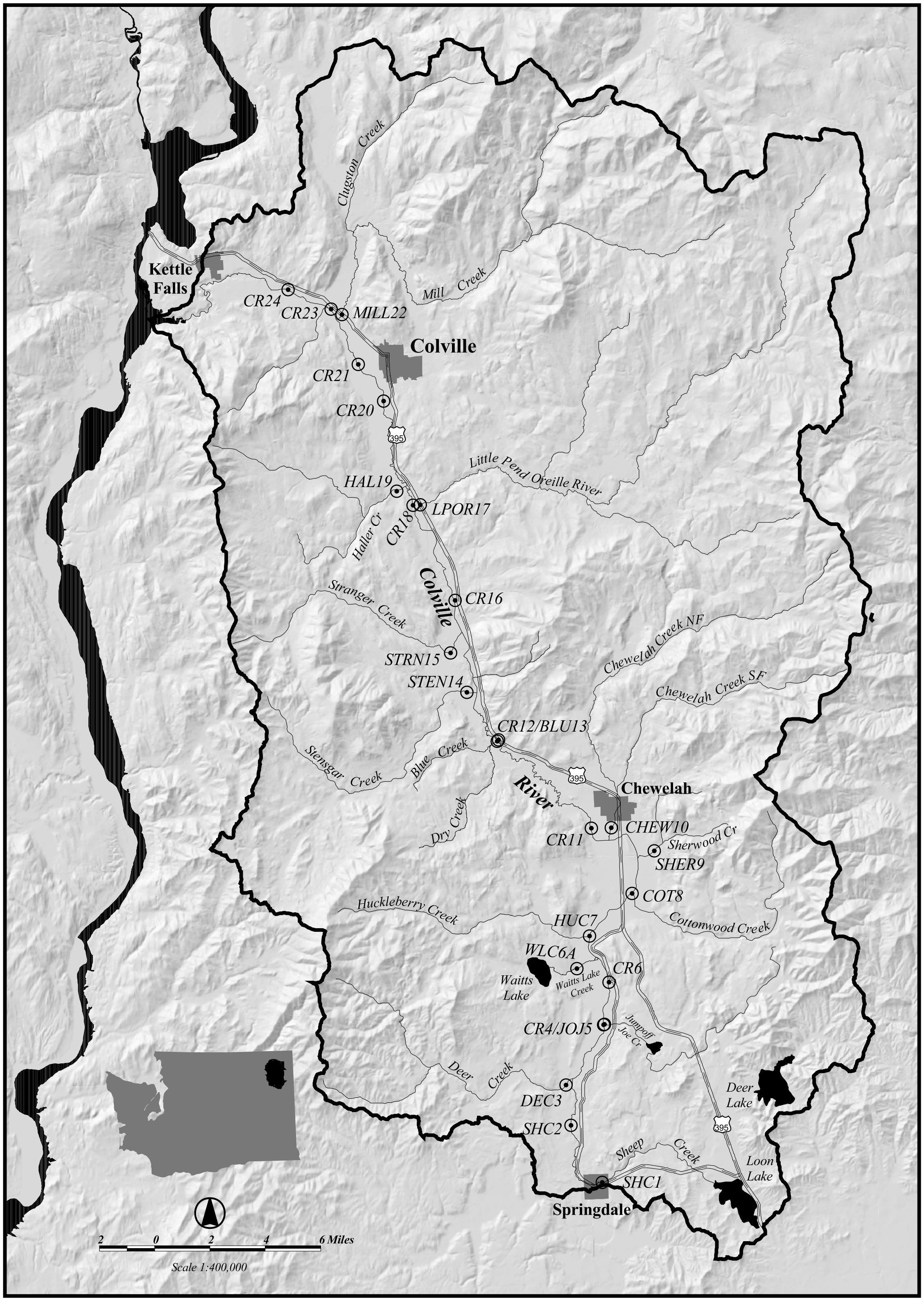


Figure 1. Study area map showing the Colville River Watershed and sampling stations.

The Colville River basin generally has a warm and dry continental climate, due to the Cascade Mountains to the west acting as a barrier for eastward moving marine air. To the north and east of the basin, the Rocky Mountains shield the area from extreme cold moving south from Canada, but occasionally spilling into the basin for short periods during the winter months. Monthly average temperatures at Colville range from 24.3° F in January to 68.4 ° F in July. Precipitation averages 17.2 inches per year at Colville. The range for the period 1917 to 2000 was 8.22 inches to 29.02 inches (WRCC, 2002). About two-thirds of the total annual precipitation in the basin falls between October and March. Areal distributions of precipitation are affected by topography due to the relationship between precipitation and altitude. Significant differences in precipitation occur between the valley and uplands, and from the windward side of the valley (east) to the leeward (west). The average seasonal snow fall is about 48 inches and covers the ground much of the winter.

Colville River discharge is driven by a snow-melt regime. The high-flow period is in the spring as a result of melting of the previous winter snow pack, in combination with spring rainfall. April is the highest month for discharge, while August is the lowest. The majority of the tributaries to the Colville River are small, generally averaging less than 20 cfs, except for Chewelah Creek, Little Pend Oreille River, and Mill Creek. These three large streams account for just over half of the Colville River discharge. Sheep Creek, a headwater stream, is the only other tributary accounting for more than 5% of the river volume, at about 5.9%.

Eighty-two percent of the land cover for the Colville River basin is within forest, shrubland, woody wetlands, and upland grasses. Most of the remainder is divided between agriculture and transitional/barren grounds. Less than 2% of the basin is covered by urban, residential, commercial/industrial, transportation, and recreational grasses. The urban/residential areas of the watershed are near the population centers of Chewelah, Colville, Kettle Falls, Springdale, and along portions of the highway corridors. The vast majority of the housing is single family residences. The sub-basins are rural/residential, with agriculture the predominant land use along the valley bottoms and on some terraces higher up. The uplands are dominated by evergreen forest, accounting for about 75% of the basin.

Table 1 presents the generalized land cover distributions for the Colville River basin, while the breakdown of individual categories and their definitions are contained in Appendix C. Appendix D presents sample site descriptions, the square mile area of the basin draining to each sample site, and land cover percentages by category.

Table 1. Generalized land cover for the Colville River basin.

Land Cover	Percent of Basin
Forests/Shrublands/Woody Wetlands/Upland Grasses	82
Agriculture	10
Barren Ground	6
Urban/Residential/Commercial/Industrial/Transportation	1
Open Water/Herbaceous Wetlands	1

Problem Description

Under section 303(d) of the 1972 federal Clean Water Act, states are required to submit a list to the U.S. Environmental Protection Agency (EPA) every two years for impaired waters that do not, or are not expected to, support beneficial uses. For those 303(d) waters, Ecology or the EPA are required to develop TMDLs to establish water-quality-based controls. High bacteria levels in the Colville River and tributaries are not supportive of recreational uses such as swimming and secondary contact such as fishing. Ecology's Ambient Monitoring Section has collected data at long-term stations on the Colville River near the communities of Kettle Falls and Bluecreek for a number of years. Bacteria levels have exceeded water quality standards often during the dry season.

The Colville River was proposed as a high priority for TMDL evaluation by Ecology's Eastern Regional Office in the 1994 Needs Assessment for the Upper Columbia Water Quality Management Area (Cornett, 1994). In response to the Needs Assessment, Ecology conducted a study to determine the capacity of the Colville River to assimilate pollutant loads and then recommended TMDL evaluations (Pelletier, 1997). The Pelletier study identified pollution by FC bacteria as a significant problem and estimated nonpoint loading along the shoreline of the river was equivalent to direct loading of approximately 100 cows or 400 humans – and roughly five times greater than the total load from tributary and headwater sources.

In a 1997 Needs Assessment (Knight and Parodi, 1997), the Eastern Regional Office rated the Colville River as the highest priority for a TMDL evaluation for the entire Upper Columbia Water Quality Management Area, which includes WRIAs 52, 53, 58, 59, 60, and 61.

The present study found FC bacteria exceeding water quality standards in the Colville River and tributaries throughout the summer months.

The Colville River and six tributaries were placed on the 1996 303(d) list for not supporting beneficial uses due to bacteria violations (Ecology, 1996). The 1998 303(d) list has nine Colville River segments and 15 tributary segments listed for bacteria violations (Ecology, 2000). This study found an additional three Colville River and two tributary segments not meeting water quality standards.

The 1998 303(d) list is more specific as to the location of problem areas, by listing river segments roughly one mile in length where the samples were collected. Table 2 presents the Colville River and tributary segments on the 1998 303(d) list for bacteria. The old waterbody number, new waterbody number, and stream name are shown. Impaired segments identified in the present study but not listed are also presented. Figure 2 shows the locations of the 1998 303(d) listed segments on a basin map.

Table 2. Water quality limited segments for FC bacteria in the Colville River basin.

Washington State 1998 303(d) list for bacteria		
1996 Waterbody Number	1998 Waterbody Number	Stream Name
WA-59-1010	DH01PX6.850	Colville River
WA-59-1010	DH01PX16.882	Colville River
WA-59-1010	DH01PX22.274	Colville River
WA-59-1010	DH01PX25.804	Colville River
WA-59-1010	DH01PX54.306	Colville River
WA-59-1010	DH01PX56.721	Colville River
WA-59-1010	DH01PX65.104	Colville River
WA-59-1010	DH01PX81.689	Colville River
WA-59-1010	DH01PX83.354	Colville River
None	GC63AN0.000	Huckleberry Creek
WA-59-2000	NO98KK0.000	Mill Creek
WA-59-2810	KR71AJ0.000	Jump-Off-Joe Creek
WA-59-2950	GQ24CK0.000	Haller Creek
WA-59-3000	YA89GE0.000	Little Pend Oreille River
WA-59-3900	XA81YE0.476	Stranger Creek
WA-59-4000	QE64YM0.000	Stensgar Creek
WA-59-5000	UR95XB0.000	Blue Creek
WA-59-6000	QM52AR0.000	Chewelah Creek
WA-59-6010	FU01VK13.092	S.F. Chewelah Creek
WA-59-6090	KH80UT0.000	Sherwood Creek
WA-59-6100	GT96PS0.000	Cottonwood Creek
WA-59-6110	GT96PS14.118	Cottonwood Creek
WA-59-7000	UD18TQ0.000	Sheep Creek
WA-59-7000	UD18TQ1.583	Sheep Creek
WA-59-1010	DH01PX18.225*	Colville River
WA-59-1010	DH01PX34.258*	Colville River
WA-59-1010	DH01PX43.733*	Colville River
None	XH00FW0.000*	Waitts Lake Creek
None	DZ53HH0.000*	Deer Creek

* = Segments found water quality limited but not listed on the 1998 303(d) list.

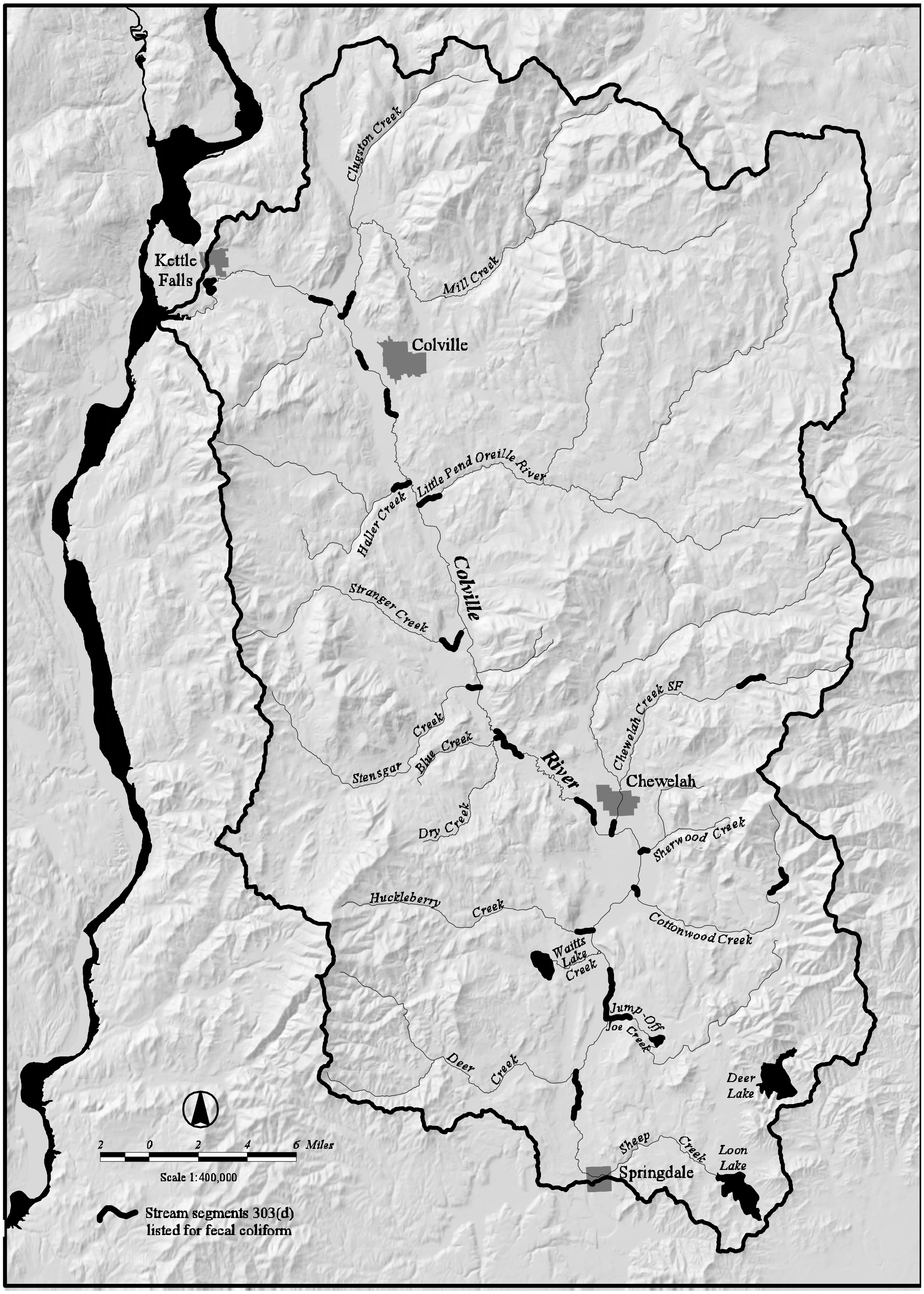


Figure 2. Colville River and tributary segments 303(d) listed for fecal coliform.

Applicable Water Quality Standards

The Colville River and its tributaries are designated by Washington State's Water Quality Standards (Chapter 173-204A-130 WAC) as Class A. Class A waters are considered "excellent". The water quality standards also designate beneficial uses within classes that water quality criteria are intended to protect. Characteristic uses of Class A waters include protection for: water supply, stock watering, fish and shellfish, wildlife habitat, recreation, and commerce and navigation. The Colville River and many of its tributaries are not fully supporting beneficial uses as shown by past and recent violations of the water quality standards (Ecology, 1996; 2000). Table 3 lists the characteristic uses of Class A waters and the water quality criteria that apply.

Project Goals and Objectives

The goal of this TMDL study is to develop a water cleanup plan to bring the Colville River and tributaries into compliance with Washington State water quality standards for bacteria. This will be done by assessment of current conditions and recommendations for load reductions necessary to attain full support of beneficial uses. Implementation of measures to achieve recommended load reductions should bring the Colville River and tributaries into compliance with Class A water quality standards.

Objectives of the study are to:

- Characterize FC bacteria density and loads in the Colville River and tributaries.
- Identify relative contributions of FC bacteria loading from near-shore and tributaries to the Colville River.
- Establish load reductions from nonpoint sources to support a TMDL as required under Section 303(d) of the federal Clean Water Act.

Table 3. Surface water quality standards for Class A freshwater (Chapter 173-201A WAC).

Class A (excellent).

General Characteristic. Water quality of this class shall meet or exceed the requirements for all or substantially all uses.

Characteristic Uses. Characteristic uses shall include, but not be limited to, the following:

- Water supply (domestic, industrial, agricultural).
- Stock watering.
- Fish and shellfish:
    - Salmonid migration, rearing, spawning, and harvesting.
    - Other fish migration, rearing, spawning, and harvesting.
    - Clam, oyster, and mussel rearing, spawning, and harvesting.
    - Crustaceans and other shellfish (e.g., crabs, shrimp, crayfish, scallops) rearing, spawning and harvesting.
- Wildlife habitat.
- Recreation (primary contact recreation, sport fishing, boating, and aesthetic enjoyment).
- Commerce and navigation.

Water Quality Criteria:

Fecal coliform organisms: Freshwater – fecal coliform organism levels shall both not exceed a geometric mean value of 100 colonies/100 mL, and not have more than 10 percent of all samples obtained for calculating the geometric mean value exceeding 200 colonies/100 mL.

Dissolved oxygen: Freshwater – dissolved oxygen shall exceed 8.0 mg/L.

Total dissolved gas shall not exceed 110 percent of saturation at any point of sample collection.

Temperature shall not exceed 18.0^{o} C (freshwater) due to human activities. When natural conditions exceed 18.0^{o} C (freshwater), no temperature increases will be allowed which will raise the receiving water temperature by greater than 0.3 ^{o} C. Incremental temperature increases resulting from point source activities shall not, at any time, exceed t=28/(T+7) (freshwater). Incremental temperature increases resulting from nonpoint source activities shall not exceed 2.8 ^{o} C. For the purposes hereof, "t" represents the maximum permissible temperature increase measured at a mixing zone boundary; and "T" represents the background temperature as measured at a point or points unaffected by the discharge and representative of the highest ambient water temperature in the vicinity of the discharge.

pH shall be within the range of 6.5 to 8.5 (freshwater) with a human-caused variation within the above range of less than 0.5 units.

Turbidity shall not exceed 5 NTU over background turbidity when the background turbidity is 50 NTU or less, or have more than a 10 percent increase in turbidity when the background turbidity is more than 50 NTU.

Toxic, radioactive, or deleterious material concentrations shall be below those which have the potential either singularly or cumulatively to adversely affect characteristic water uses, cause acute or chronic conditions to the most sensitive biota dependent upon those waters, or adversely affect public health, as determined by the department.

Aesthetic values shall not be impaired by the presence of materials or their effects, excluding those of natural origin, which offend the senses of sight, smell, touch, or taste.

Methods

Study Design

The objectives of the project were met through a combination of water quality and discharge data collection, and the analysis of loading scenarios and resulting water quality. The monitoring was designed to evaluate spatial and temporal patterns in loads from near-shore areas along the Colville River and tributaries.

FC bacteria surveys were conducted every two weeks from March 2000 through March 2001. As cooperators in the project, personnel from the Stevens County Conservation District (SCCD) collected the water quality samples and most of the discharge data. Ecology staff also conducted two synoptic surveys for a suite of conventional and biological parameters. These surveys occurred in July and September 2000. Additional water quality parameters were included in synoptic surveys to compare to results from earlier studies for possible expansion of the project in the future. Synoptic surveys were conducted at the request of Ecology's Eastern Regional Office and Water Quality Program.

Sampling Sites

The monitoring network for bacteria surveys and the two synoptic surveys was made up of 10 mainstem sites and 15 tributary sites (Figure 1 and Table 4). Sampling locations were the same as those used in studies by Pelletier (1997) and the SCCD (1993). Sites were identified by an alphanumeric label. Descriptions of sample site locations, latitude and longitude coordinates, and the associated sub-basin land cover breakdowns are presented in Appendix D.

Point sources of pollution were not evaluated in this study. Currently there are two municipal wastewater treatment plants discharging to the Colville River – from the cities of Colville and Chewelah. Both have recently undergone upgrades to their systems, and NPDES permits were reissued August 2001 and December 2000, respectively. Permits require FC monitoring and end-of-pipe compliance for both plants. The FC permit limits have a seasonal component. From June through October, plant discharge is required to meet a FC limit of 100 cfu/100 mL monthly average, and a 200 cfu/100 mL weekly average. The rest of the year, FC limits are 200 cfu/100 mL and 400 cfu/100 mL.

Table 4. Sampling sites for the Colville River bacteria TMDL study, March 2000-March 2001.

Site ID	Site Name	River Mile*	Stream Type	Drainage (mi^2)
SHC1	Sheep Creek in Springdale	59.6	Headwater	54.0
SHC2	Sheep Creek at Forest Ctr. Rd	59.6	Headwater	60.5
DEC3	Deer Creek at Deer Creek Rd	59.6	Headwater	42.1
CR4	Colville River at Betteridge Rd	56.81	Mainstem	122.5
JOJ5	Jump-Off-Joe Creek at the mouth	56.80	Tributary	15.6
CR6	Colville River at Waitts Lake Road	55.0	Mainstem	165.3
WLC6A	Waitts Lk Cr at Farm-to-Market Rd	53.8	Tributary	12.5
HUC7	Huckleberry Creek at the mouth	52.8	Tributary	41.1
COT8	Cottonwood Creek at the mouth	50.2	Tributary	33.7
SHER9	Sherwood Creek at Cottonwood Cr Rd	48.6	Tributary	11.5
CHEW10	Chewelah Creek at Alm Lane	46.7	Tributary	93.2
CR11	Colville River at Alm Lane	45.7	Tributary	389.5
CR12	Colville River at Bluecreek	37.1	Mainstem	426.7
BLU13	Blue Creek in Bluecreek	37.13	Tributary	16.1
STEN14	Stensgar Creek at the mouth	32.2	Tributary	56.0
STRN15	Stranger Cr at Marble Valley Basin Rd	29.4	Tributary	42.5
CR16	Colville River at 12 Mile Rd	28.0	Mainstem	557.5
LPOR17	Little Pend Oreille River at Hwy 395	23.2	Tributary	187.3
CR18	Colville River at Arden Hill Rd	23.0	Mainstem	750.9
HAL19	Haller Creek off Skidmore Rd	21.8	Tributary	37.6
CR20	Colville River at Mantz-Rickey Rd	16.4	Mainstem	800.2
CR21	Colville River at Oakshot Rd	14.3	Mainstem	817.2
MILL22	Mill Creek at Highway 395	12.0	Tributary	141.2
CR23	Colville River at Gold Creek Rd	11.5	Mainstem	973.2
CR24	Colville River Greenwood Loop Rd	9.2	Mainstem	985.7

* River mile for the headwater streams is the beginning of the Colville River at the confluence of Sheep Creek and Deer Creek. River mile for tributary streams is the location of the confluence with the Colville River.

Flow

Within the study area, there was only one long-term flow monitoring station collecting daily discharge information. The U.S. Geological Survey (USGS) has operated the Colville River at Kettle Falls gaging station (USGS 12409000) from 1923 to the present. Discharge information for tributaries was not available, so a network of five flow monitoring stations at key locations in the basin were established by Ecology personnel. Hourly flow information was generated for Chewelah Creek, Little Pend Oreille River, Mill Creek, Stensgar Creek, and the Colville River at the community of Bluecreek. Stage height was recorded by pressure transducer and data logger. Flow was measured over the range of discharge to allow development of rating curves. At sample sites without a gaging station, stage height was measured from installed staff gages or tape downs from bridges. At monitoring sites where flow measurement was possible, discharge was determined during sampling events. Flow rating for ungaged sites was accomplished by developing relationships between instantaneous measurements with continuous measurements at other locations.

Daily discharge estimates were generated for all 25 sites using a number of techniques. For the period prior to gaging station installation, at sites where flow measurement was not possible, or the period after December 12, 2000 due to ice, discharge estimates for sample locations were developed using the sites sub-basin annual precipitation compared to the Kettle Falls sub-basin annual precipitation. Daily discharge was estimated by determining the ratio of the sites mean annual volume of precipitation, in cubic feet per second (cfs), to the Kettle Falls mean annual volume of precipitation. That ratio as a percent was then applied to the Kettle Falls discharge to determine flow at other sites in the basin.

Rating curves were developed for sites where stage-height to streamflow relationships were possible. Stage height was determined by pressure transducer or measurement from a fixed point such as a staff gage or tape-down from road bridges. The hourly measurements from pressure transducers were averaged for each 24-hour period for a daily average. For streamflow estimation, a variety of regressions were reviewed to find the one that most closely fit measured flows. At times, more than a single regression was needed for a site to address the change in flow conditions, such as high or low flow, or changing a gage location.

Table 5 presents the equations for estimating flows for the Colville River TMDL and comparisons of estimated to measured flow for the study. Other sites or periods not listed used the mean annual volume of precipitation ratio compared to Kettle Falls.

Table 5. Flow estimate equations for the bacteria Colville River TMDL study.

Stream	Regression Pair	Regression Equation	R^2	Percentage Estimated to Measured Qs	Period
Colville River/CR12	CR12 Q to Kettle Falls Q	$y=0.3280x + 38.2198$	0.96	99.6	Q>250 cfs
Colville River/CR12	CR12 Q to gage	$y=427.1560\mathrm{Ln}(x) - 316.0814$	0.96	101.7	Q<250 cfs
Chewelah Creek	CHEW10 Q to gage	$y=63.8111x - 79.1544$	0.99	102.6	5/10/00 to 3/27/01
Little Pend Oreille	LPOR Q to Mill Q	$y=0.4106x^{1.1738}$	0.98	95.1	Q>100 cfs
Little Pend Oreille	LPOR Q to Kettle Falls Q	$y=0.1268x^{1.0740}$	0.98	106.2	Q<100 cfs
Mill Creek	MILL Q to Kettle Falls Q	$y=0.0583x^{1.1937}$	0.97	99.9	Q>200 cfs
Mill Creek	MILL Q to gage	$y=143.9134x - 111.7798$	0.99	114.0	Q<200 cfs
Stensgar Creek	STEN Q to gage	$y=81.0686\mathrm{Ln}(x) - 49.9901$	0.93	103.6	Q>10.0 cfs
Stensgar Creek	STEN Q to gage	$y=29.0808\mathrm{Ln}(x) - 11.2913$	0.95	101.5	Q<10.0 cfs

Sampling Procedures

Sample collection, handling, and measurement procedures followed those described in Ecology's Watershed Assessment Section (WAS) protocols (WAS, 1993). Grab samples were collected at wrist depth directly into pre-cleaned containers supplied by Manchester Environmental Laboratory and described in the *Manchester Environmental Laboratory Lab Users Manual* (MEL, 1994). All meters were calibrated in accordance with the manufacturer's recommendations.

Gaging stations were developed based on procedures described in the WAS protocol manual (WAS, 1993). Calculation of discharge was based on procedures described in the WAS protocol manual and *Open-Channel Hydraulics* (Chow, 1959). Continuous data for hourly stage height was recorded by Unidata data loggers and pressure transducers.

Analytical Procedures

A summary of the field and laboratory measurements, target detection limits, and methods for analyses of conventional and biological parameters is listed in Table 6. The analysis for E. coli and enterococci was included at the request of Ecology's water quality program. Ecology is currently reviewing the bacteria water quality criteria, with the possibility of changing it to either E. coli or enterococci (WQP, 1999). The additional parameters were analyzed in the event the bacteria standards were changed during the course of the project. Field sampling and measurement techniques followed procedures described in the WAS protocol manual (WAS, 1993).

Quality Assurance and Quality Control

Bacteria discharged from nonpoint sources of pollution tend to be more inherently variable than other water quality parameters. This is because bacterial populations have a patchy distribution in the environment and are intermittently discharged. Standardized field sampling, holding times, and shipping procedures were employed to minimize variability.

To determine the quality of bacteria data, an estimate for the precision of the bacterial analysis was needed. Precision is estimated by collection and analysis of field replicates and laboratory splits. Replicate samples were collected at a rate between 10% and 20% per survey day. Lab splits were analyzed at a rate of two per sample batch.

To quantify the variability of the bacteria analysis, the coefficient of variation (CV) was calculated for sample pairs and lab splits, and expressed as the percent difference. Over the study period, 80% of the stations were sampled in replicate to assess total variability of the analysis. Total variability from field replicates and laboratory variability from lab splits were quantified by calculating the CV from sample pairs. The CV is calculated by dividing the standard deviation of the replicate pair by their mean. The root mean square coefficient of

Table 6. Summary of field and laboratory measurements, target detection limits, and methods.

Parameter	Target Sensitivity or Reporting Limit	Method*
Field Measurements		
Temperature	$\pm$ 0.2 ^oC	Alcohol Thermometer
Velocity	$\pm$ 0.05 f/s	Marsh-McBirney Current Meter
Stage Height	$\pm$ 0.02 feet	Staff Gage
Stage Height Continuous	$\pm$ 0.01 feet	Pressure Transducer
General Chemistry/Microbiology		
Specific Conductance	1 *u*mhos/cm at 25 ^oC	SM 20, 2510
Fecal Coliform	2 cfu/100 mL	SM 20 MF 9222D
E. coli	2 cfu/100 mL	EPA 1105
Enterococci	2 cfu/100 mL	SM 20 MF 9230C/EPA 1600
Ammonia Nitrogen	0.01 mg/L	EPA 350.1
Nitrate + Nitrite	0.01 mg/L	EPA 353.2
Total Persulfate Nitrogen	0.01 mg/L	SM 20 4500 NO_3-F Modified
Orthophosphate	0.01 mg/L	EPA 365.3
Total Phosphorus	0.01 mg/L	EPA 365.3
Total Organic Carbon	1 mg/L	EPA 415.1
5-Day BOD	2 mg/L	EPA 405.1
Ultimate Carbonaceous BOD	2 mg/L	NCASI (1987)
Phytoplankton ID/Biovolume	--	SM 20 10200F; Sweet (1987)
Chlorophyll *a*	0.05 *u*g/L	SM 20 10200H(3), fluorometer

* SM = *Standard Methods for the Examination of Water and Wastes, Twentieth edition.* American Public Health Association, American Water Works Association, and Water Environment Federation. Washington D.C.

EPA = *Methods for the Chemical Analysis of Water and Wastes.* Environmental Monitoring Supply Laboratory. U.S. Environmental Protection Agency. Cincinnati, OH. EPA-600/4-74-020. 1983.

NCASI = A procedure for the estimation of ultimate oxygen demand (biochemical). National Council of the Paper Industry for Air and Stream Improvement, Inc. Special Report No. 87-06. May 1987.

Sweet (1987) = Phytoplankton of Selected Northwest Lakes and Rivers. Final report prepared for the U.S. Environmental Protection Agency, Region X, Seattle, WA. Project Officer: Dave Terpening. Prepared by J.W. Sweet. June 1987.

variation (RMSCV) was calculated from the pooled replicate pairs for the study. The RMSCV for field replicates was 28%, while lab split samples had a RMSCV of 23% (Appendix A, Figure A1). Other recent FC TMDL studies conducted by Seiders *et al.* (2001) and Joy (2000) found similar variability for field replicates, at 19% and 28%, respectively. The FC data for the project was considered acceptable as qualified, based on bacteria variability reported in comparable studies and meeting data quality objectives of the quality assurance project plan.

Data generated from the laboratory quality control samples for bacteria met all quality assurance requirements and were considered acceptable as qualified. Manchester Laboratory routinely runs two split samples per survey batch and two blanks, one before and one after each sample run, to check for dilution water quality. No blank contamination was found during analysis of project samples.

All samples for bacterial analysis met the holding time established by Manchester Laboratory at the onset of the project. The nitrite results for the synoptic survey of September 19 and 20 did not meet holding time requirements. Results were "J" estimated, due to analysis being performed beyond the 24-hour holding time. No nitrite results were reported above the method detection limit. Also, from the same survey 14 of the 25 chlorophyll *a* samples were "J" estimated due to filtering not being completed before the 24-hour holding time.

Data Assessment Procedures

The data reduction, review, and reporting followed procedures outlined in the *Manchester Environmental Laboratory Lab Users Manual* (MEL, 1994). Data were transferred to the principal investigator electronically from the laboratory information-management system (LIMS) to avoid transcription errors. Before data were entered into the final project database, 100% of the data were reviewed for missing or improbable values.

Project data were entered into Excel spreadsheets for calculation of statistics. USGS flow data and SCCD field data were also included to meet project objectives. Flow data from the Kettle Falls gaging station (station 12409000) were obtained from the USGS web-site. USGS flow data are considered provisional until reviewed and published. Staff from the USGS Spokane Office familiar with the gaging station consider discharge to be accurate within ±10% (Ray Smith, personal communication). USGS data for Kettle Falls were considered acceptable as presented.

Representativeness

The sampling design ensured that the data are representative of water quality conditions within the basin. To cover the range of flow/runoff events, sites were sampled every two weeks for 27 surveys, except sites CR20, CR11, and WLC6A (Figure 1) which missed the December 18 and 19 sample event due to frozen conditions. The surveys scheduled during the weeks of July 4th and Thanksgiving had to be rescheduled for later in the study to accommodate the laboratory. To assess the total variability of the bacteria data (field variability plus laboratory variability), a minimum of 10% of the stations per survey day were sampled in replicate (defined as one sample or measurement taken immediately following the first).

Results and Discussion

Water Quality Monitoring Results

The complete database of water quality results from samples collected during the present March 13, 2000 through March 27, 2001 study are contained in Appendix B, Tables B1 – B7. Bacteria results for FC, E. coli, enterococcus, and temperature are presented. Results for the two synoptic surveys that included phytoplankton analysis also are presented. As stated previously, samples were analyzed for E. coli and enterococcus, in the event the water quality standard for bacteria was changed. E. coli analysis was conducted for the March through August 2000 surveys, while enterococcus was analyzed for the August 2000 through March 2001 surveys. A summary of the study results for FC are presented in Table 7. Information is provided on the minimum, maximum, geometric mean, and 90th percentile of the FC results for the survey period. Also included is the site identification, river mile or tributary mile for tributaries, number of samples collected per site, and number of samples greater than 100 cfu/100 mL.

Often in basins with nonpoint source pollution problems, there is a period of the year when water quality is at its worse. In some watersheds, this is during the wet season when bacteria are wash-off driven from precipitation. The period with the highest bacteria density in the Colville River is the dry season, between June and September, when livestock are accessing streams and waste from septic systems are exacerbated by low flow, minimizing dilution. During this period all of the Colville River mainstem sites, except CR24, violated both levels of the bacteria standard. The CR24 site did not violate bacteria standards, likely due to dilution from higher quality surface and ground water. During this period, all of the tributary sites, except SHC1, violated the second level of the bacteria standard. The headwater site SHC1 did not violate bacteria standards. It flows from the uplands, which are largely undeveloped, with an intact riparian area.

Table B1 presents the bacteria results for the Colville River basin, while figures A2 – A26 show graphs of FC density and loads for each site and survey. Excess FC was generally found during the dry period, between June and September. The upper basin (*i.e.,* above river mile 50) Betteridge Road (CR4) and Colville River at Valley (CR6) sites were most likely to exceed bacteria standards. In the middle basin (*i.e.,* between river miles 30 and 50), Blue Creek (BLU13) and Stranger Creek (STRN15) were the sites most likely to exceed standards. In the lower basin, the dry season was still the problem period, but dilution from cumulative discharge and groundwater likely moderate much of the higher values.

The Blue Creek site (BLU13) in Bluecreek had the highest geometric mean for the study period, at 182 cfu/100 mL. The stream runs through the old community of Bluecreek, which has a high probability for old or substandard septic systems. Blue Creek was the only study site having the highest three-month FC density outside the June through September period. The three-month high FC density for Blue Creek was between November and January. Livestock are unlikely to access the stream during this time, which leaves septic systems as a likely source.

Table 7. Summary of fecal coliform density in the Colville River and tributaries during the March 2000 through March 2001 study period.

Station ID	River Mile*	Tributary Mile**	No. of Samples	Samples > 100 cfu/100 mL	Fecal Coliform (colony forming units / 100 mL) Minimum	Maximum	Geometric Mean	90th Percentile
CR 24	9.2		27	1	1	160	22	136
CR 23	11.5		27	5	1	590	17	156
MILL22	12.0	0.37	27	8	3	240	38	187
CR 21	14.3		27	6	1	230	17	196
CR 20	16.4		26	5	1	330	23	171
HAL 19	21.8	0.61	27	5	1	3500	18	201
CR 18	23.0		27	6	1	360	28	173
LPOR 17	23.2	0.27	27	3	1	210	18	90
CR 16	28.0		27	8	2	320	34	203
STRN 15	29.4	1.07	27	11	9	2000	107	937
STEN 14	32.2	0.42	27	6	5	660	45	239
BLU 13	37.13	0.07	27	19	9	3700	182	1042
CR 12	37.1		27	10	9	360	57	233
CR 11	45.7		26	8	1	410	41	296
CHEW 10	46.7	0.54	27	6	1	230	41	203
SHER 9	48.6	0.82	27	5	1	1700	23	273
COT 8	50.2	0.01	27	5	3	320	29	143
HUC 7	52.8	0.01	27	4	1	300	18	132
WLC6A	53.8	1.07	26	5	1	870	23	238
CR 6	55.0		27	14	3	700	91	651
JOJ 5	56.80	0.01	27	4	1	330	12	132
CR 4	56.81		27	12	2	1400	84	692
DEC3	59.6	0.55	27	4	1	530	11	125
SCH 2	59.6	3.20	27	7	8	770	54	225
SCH 1	59.6	7.26	27	2	5	160	27	78

* = River mile for tributaries refers to the location of the confluence with the Colville River.
** = Tributary mile refers to the site distance upstream from the confluence with the Colville River.

The discharge from Blue Creek accounts for only about 1.4% of the Colville River flow, averaging 5.60 cfs for the study period, so the impact to the Colville River is partially mitigated by dilution. Currently, work is underway to extend sewer lines to Bluecreek from the new collection system and treatment plant under construction for the community of Addy. It is expected that Bluecreek homes will be hooked up to the system in late 2002.

Water temperature through the study was generally below the 18^{o}C water quality standard. Temperature exceeded the standards during two sample surveys of mid to late July. Temperature exceeded water quality standards at three sites during the July 17 survey. During the July 31 survey, temperature exceeded the water quality standard at 11 of the 25 sites (Table B4).

Temperature exceedance may be more widespread in the basin than was found in this study, because sample surveys were generally completed by 2:00 PM in order to get bacteria samples transported to the laboratory for analysis within holding times.

Flow

Based on USGS data from the Kettle Falls gaging station (USGS 12409000) located at river mile 5, April (853 cfs) and May (702 cfs) are the highest average months for discharge, while August (90.2 cfs) and September (98.1 cfs) are the lowest. The mean annual discharge is 311 cfs, based on the 1923 to the present period of record. The mean discharge for the March 2000 to March 2001 study period was 27% above average, at 394 cfs. Discharge for the study period generally followed the historical record (Figure 3). A water balance for the Colville River was generated to show discharge contributions in the basin during the March 2000 through March 2001 study.

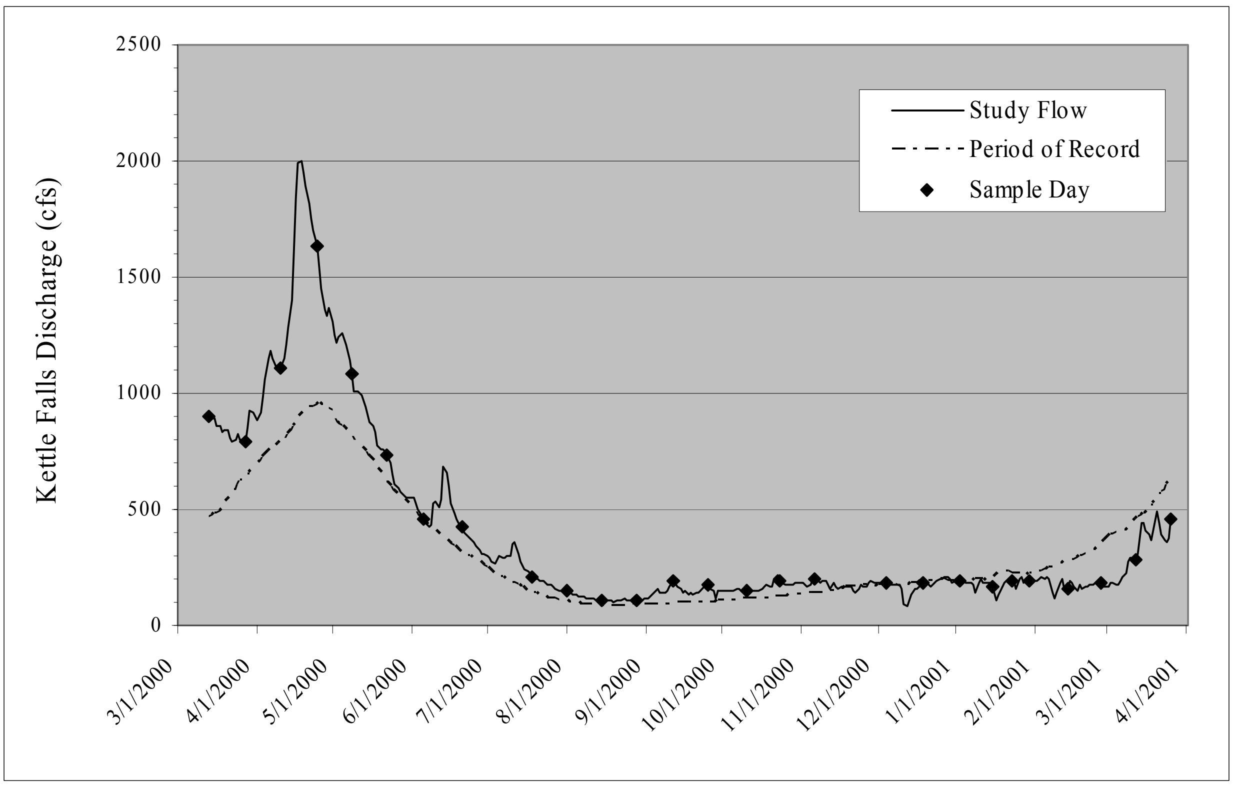


Figure 3. Colville River historical and study period discharge at the USGS Kettle Falls gaging station (12409000).

A flow balance was estimated using USGS gage records from Kettle Falls and hydrographs from Ecology's five continuous gaging stations (Figure 4). The majority of the tributaries to the Colville River are small, steep sloped in the headwaters, and empty quickly, resulting in low summer flows. Over half of the volume of the Colville River is contributed by the three largest tributaries: Chewelah Creek, Little Pend Oreille River, and Mill Creek. Throughout the study, these three streams accounted for about 54% of the Colville River discharge. Sheep Creek, a headwater stream, is the only other tributary contributing more than 5% of the total river volume, at about 5.9%.

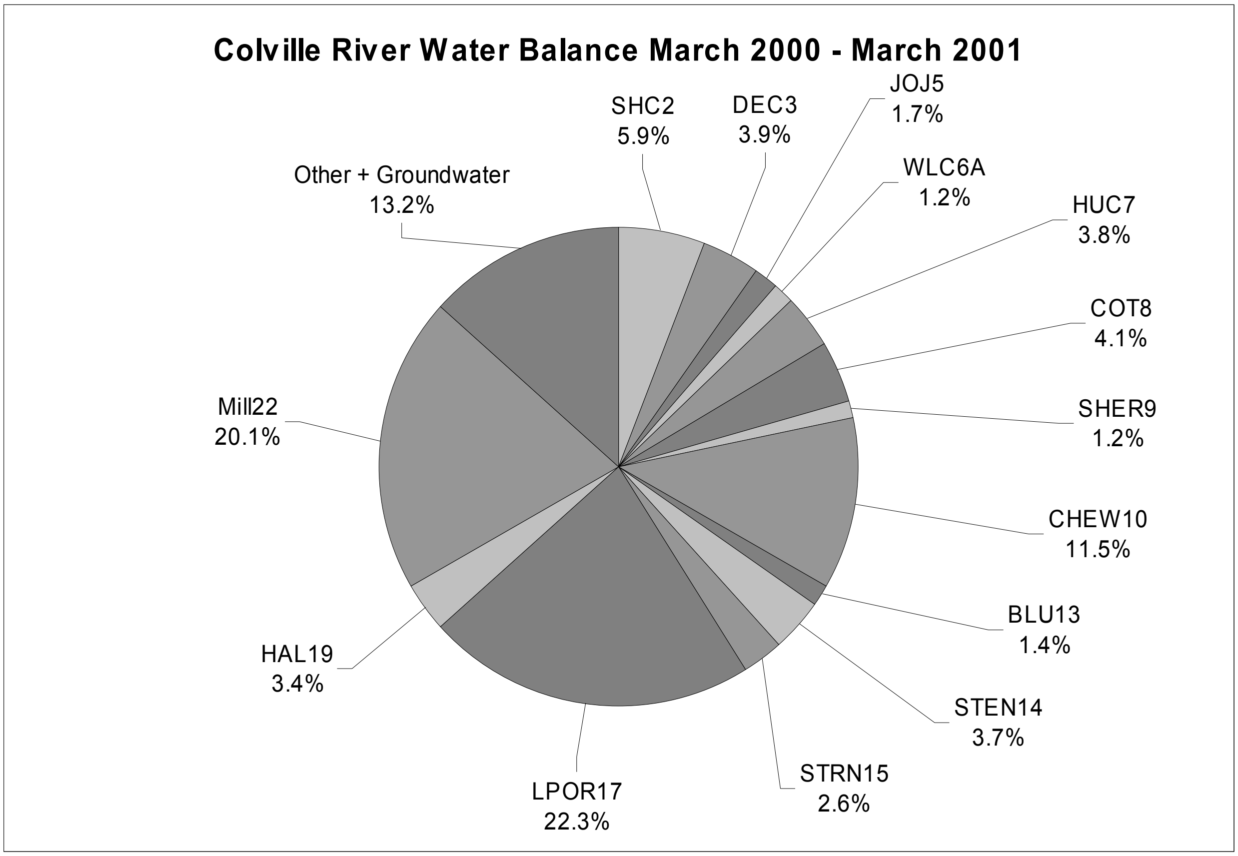


Figure 4. Estimated tributary contribution to the Colville River for the March 2000 through March 2001 study period.

A list showing sample day discharge for each site is presented in Appendix B, Table B7. Table 8 below presents the average study period flow (cfs) and percentage of the sub-basin contribution to the discharge at the USGS Kettle Falls gaging station.

Table 8. Summary of sub-basin average flow (cfs) for the Colville River bacteria TMDL study.

Sub-basin	Site ID	* Average Flow (cfs)	**Percent Contribution	Sub-basin	Site ID	* Average Flow (cfs)	**Percent Contribution
CR at Greenwood Loop	CR24	388	98.4	Sheep Creek	SHC2	23.1	5.9
CR at Gold Creek Rd	CR23	383	97.4	Sheep Creek	SHC1	20.8	5.3
CR at Oakshot Rd	CR21	320	81.2	Cottonwood Creek	COT8	16.1	4.1
CR at Mantz-Rickey Rd	CR20	315	80.0	Deer Creek	DEC3	15.2	3.9
CR at Arden Hill Rd	CR18	298	75.8	Huckleberry Creek	HUC7	14.9	3.8
CR at 12 Mile Rd	CR16	204	51.7	Stensgar Creek	STEN14	14.5	3.7
CR at Bluecreek	CR12	167	42.5	Haller Creek	HAL19	13.3	3.4
CR at Alm Lane	CR11	151	38.5	Stranger Creek	STRN15	10.4	2.6
Little Pend Oreille R.	LPOR17	87.7	22.3	Jump-Off-Joe Creek	JOJ5	6.61	1.7
Mill Creek	MILL22	79.3	20.1	Blue Creek	BLU13	5.61	1.4
CR at Waitts Lk Rd	CR6	61.9	15.7	Sherwood Creek	SHER9	4.78	1.2
CR at Betteridge Rd	CR4	45.6	11.6	Waitts Lake Creek	WLC6A	4.53	1.2
Chewelah Creek	CHEW10	45.1	11.5				

* = Average flow for the study period in cubic feet per second.
** = Contribution of flows from tributaries or the mainstem at the sample point compared to the USGS Kettle Falls flow.

Loading

Bacterial loads are expressed as the product of bacterial counts and stream discharge. The result is the total number of bacteria over a period of time, usually expressed per day. Pelletier (1997) in the 1994 study found significant amounts of direct bacteria inputs to the Colville River throughout most of its length, and loads from the tributaries did not account for much of the load in the river. This 1994 study also found that loads from the tributaries did not explain the load in the Colville River. This suggests that near-shore contributions to the river are still a significant source. Bacteria loads found during the present study were lower than those from the 1994 study, but cattle were still observed using the river at a number of locations. All mainstem segment loads were greater than the tributary loads, even after removing tributary contributions. Table 9 lists the bacteria loads for each sample site calculated for the highest geometric mean three-month period. Figures A2 – A26 show the sample day load and density for each site throughout the study.

Table 9. Average bacteria loads for the highest three-month geometric mean period of the study.

Site ID	Load (cfu/day)	Site ID	Load (cfu/day)	Site ID	Load (cfu/day)	Site ID	Load (cfu/day)
CR23	6.39E+11	CR4	2.73E+11	LPOR17	9.23E+10	SHC1	1.86E+10
CR21	5.23E+11	CR6	2.50E+11	BLU13	7.18E+10	WLC6A	1.56E+10
CR18	4.80E+11	CR11	2.40E+11	STRN15	7.13E+10	JOJ5	1.09E+10
CR12	3.96E+11	HAL19	2.29E+11	DEC3	3.01E+10	SHER9	1.02E+10
CR16	3.34E+11	MILL22	1.35E+11	STEN14	2.85E+10		
CR24	3.34E+11	CHEW10	1.18E+11	COT8	2.36E+10		
CR20	2.96E+11	SHC2	1.05E+11	HUC7	2.26E+10		

To help focus follow-up work in the basin, net loads for mainstem reaches were ranked against tributary loads. Net loads were estimated at each mainstem site by removing the load of the next Colville River site upstream plus loads from tributaries discharging between. The result is a rough estimate of the near-shore contribution within the reach. Mainstem sites represented with negative values can be considered reaches without near-shore contributions. This approach does not account for biological or physical processes. It is presented for purposes of helping direct follow-up work. The bar chart below shows the ranked loads for the mainstem and tributaries based on average FC loads for the July through August 2000 period. July and August were common problem months for all sites, and were chosen to allow comparisons for the same time period.

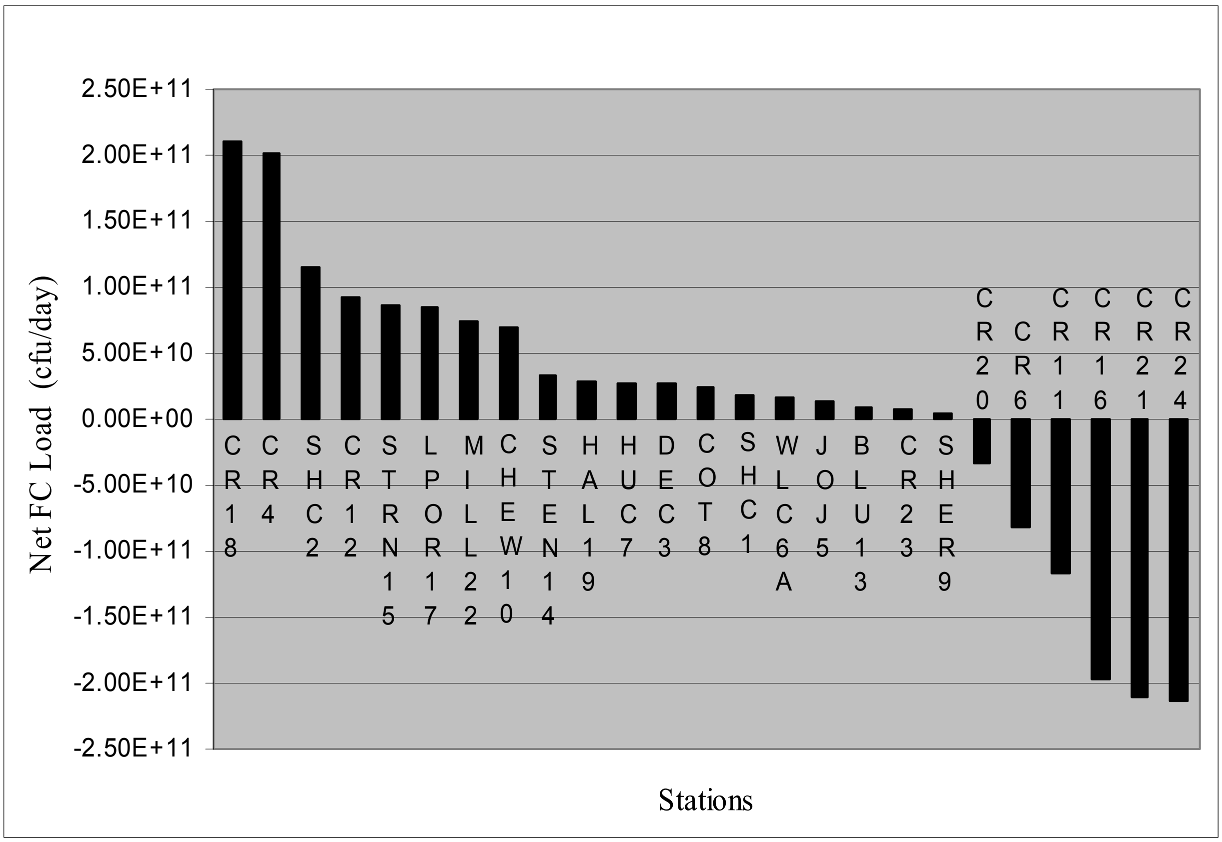
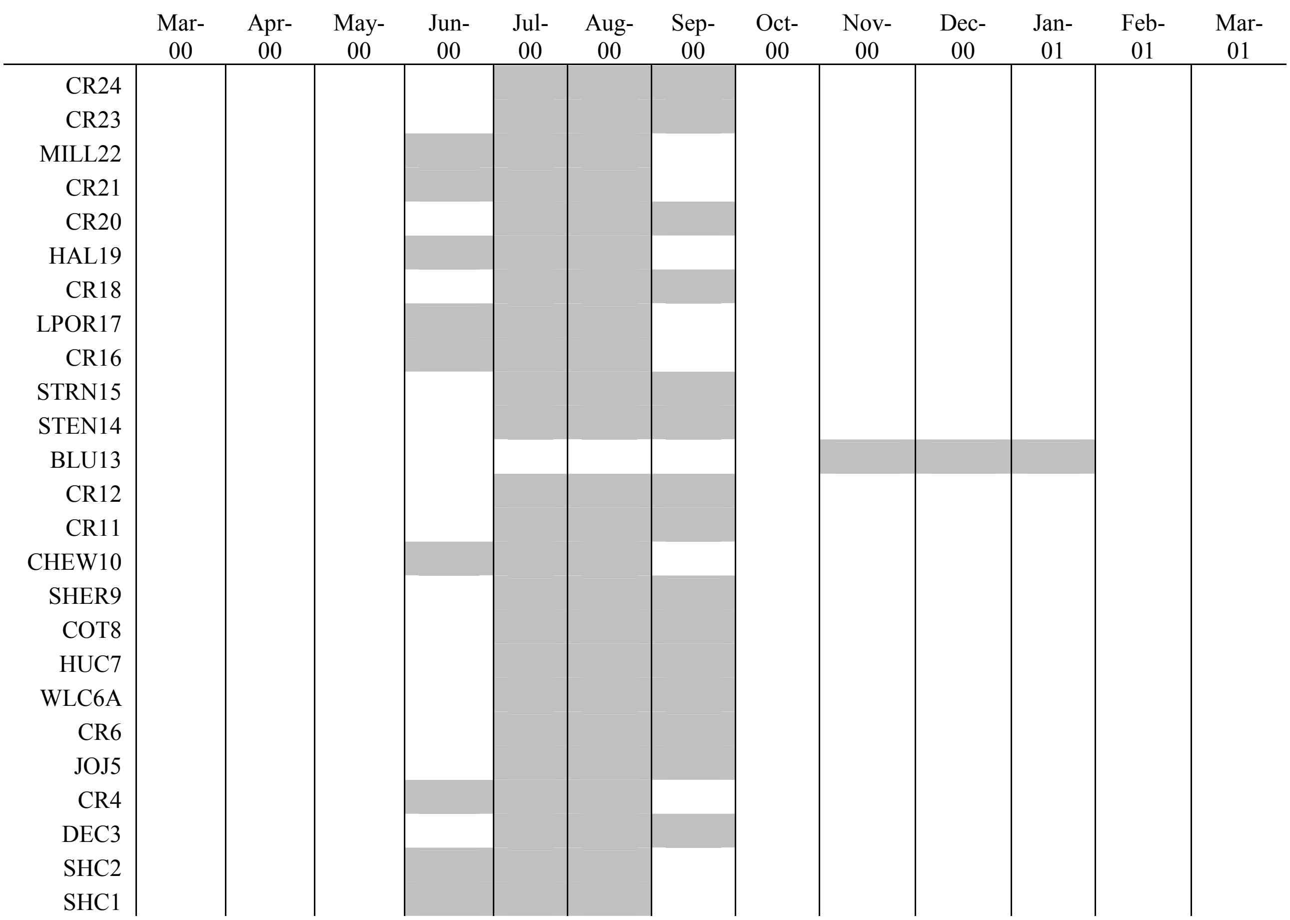


Figure 5. Ranked net fecal coliform loads for the July and August 2000 study period.

Critical Conditions

The critical condition is the period when water quality is at a reasonable worst case. Implementation measures are developed to address water quality during critical conditions. In the Colville River, the dry season, from June through September, is the period most likely to exceed water quality standards. Bacteria data collected throughout the year for this study and historical data from the Ecology Ambient Monitoring Section database (Ecology, 2002) clearly show a pattern of summertime excursions of the bacteria standards (Figures A2-A26). A three month running geometric mean bacteria density was calculated for each study site. The Blue Creek site (BLU13) in Bluecreek was the only study location with a critical period other than June through September. Blue Creek had bacteria problems through the entire study year, but the November through January period had the highest three-month geometric mean. Table 10 presents the critical condition for bacteria loading to the Colville River for each study site based on data collected from March 2000 through March 2001.

Table 10. The critical condition for bacteria loading using a rolling three-month geometric mean.



* Shaded area denotes the period with the highest three-month geometric mean bacteria count for the study.

Mainstem Load Reductions

The ultimate goal of a TMDL is to bring a waterbody into full compliance with applicable water quality standards. The state class A water quality standards require FC bacteria meet both a geometric mean no greater than 100 cfu/100 mL, and not more than 10% of the samples used for calculating the geometric mean exceed 200 cfu/100 mL. The second part of the criteria is most often violated.

To bring the Colville River and tributaries within acceptable levels of bacteria, an approach called the "statistical theory of rollback" (Ott, 1995) was used to determine load reductions needed to meet water quality standards. This technique provides a percent reduction statistic. The rollback method has been successfully used by Ecology in other FC TMDL evaluations (Seiders *et al.*, 2001; Joy, 2000; Pelletier and Seiders, 2000; Cusimano and Giglio, 1995). Further discussion of the principles and assumptions of the rollback method can be found in Joy's study (2000) for the Nooksack River basin.

To meet water quality standards in the Colville River, target load reductions for study sites were calculated. The second part of the bacteria standard requires less than 10% of all samples obtained for calculating the geometric mean value be below 200 colonies/100 mL. As an equivalent expression for the second part of the water quality standard, 90th percentiles were calculated for averaging periods. The percent reduction of the bacteria load needed at each site to meet water quality standards was calculated from the geometric mean and the 90th percentiles.

One, two, and three month running geometric means and 90th percentiles were calculated for each site. The one month averaging period was presented for information only. The small sample number from one month was insufficient as a basis for load reductions. The most conservative estimate of load reduction (highest percentage) was used from the two and three month running geometric mean and 90th percentile calculations. Tables B8 – B17 present the mainstem Colville River data for the running geometric mean and 90th percentile calculations. These data are graphically presented in Figures A27 – A36. Table 11 below summarizes the FC reduction percentages needed per mainstem segment to meet class A water quality standards for both the geometric mean and 90th percentile, and the target geometric mean. The 90th percentile estimates were generally more limiting than the geometric mean for determination of the needed rollback.

Table 11. Fecal coliform summary statistics for mainstem Colville River target load reductions from critical periods.

Site	Number of Samples	Geometric Mean	90th Percentile	Target Geometric Mean	Required Reduction
CR4	27	736	1681	81	89%
CR6	27	487	1220	78	84%
CR23	27	154	652	46	70%
CR21	27	140	473	59	58%
CR12	27	199	461	86	57%
CR18	27	146	453	64	56%
CR11	26	217	381	98	55%
CR16	27	174	427	80	54%
CR20	26	214	362	98	54%
CR24	27	93	205	90	3%

Tributary Load Reductions

Tributaries to the Colville River are also required to meet the same class A water quality standard for bacteria as the mainstem. All sampled tributaries and headwater streams require TMDL targets and load reductions to meet water quality standards. The "statistical rollback" method was applied to tributary sites to determine TMDL targets. The reduction in FC loads that was needed to meet water quality standards was calculated for each site. Presented below are the TMDL target reductions needed in tributaries based on the statistical rollback. Reductions from 4% to 95% are needed in tributaries to meet the TMDL targets for compliance with water quality standards. Tables B18 – B32 present the tributary data for the running geometric mean and 90^{th} percentile calculations. These data are graphically presented in Figures A37 – A51. Table 12 below summarizes the reductions needed to meet class A water quality standards and the target geometric mean to meet the 10% criterion of the water quality standard.

Table 12. Fecal coliform summary statistics for tributary target load reductions from critical periods.

Site	Number of Samples	Geometric Mean	90^{th} Percentile	Target Geometric Mean	Required Reduction
HAL19	27	379	3387	19	95%
SHER9	27	122	3403	6	95%
BLU13	27	411	3261	25	94%
STRN15	27	1249	2385	100	92%
SHC2	27	380	1272	57	85%
WLC6A	26	289	1168	49	83%
STEN14	27	350	1010	70	80%
DEC3	27	132	773	33	75%
HUC7	27	207	497	83	60%
JOJ5	27	220	396	99	55%
COT8	27	147	358	81	45%
CHEW10	27	154	338	91	41%
MILL22	27	132	239	99	25%
LPOR17	27	107	264	80	25%
SHC1	27	84	209	81	4%

Margin of Safety

A margin of safety (MOS) is a required component of TMDLs. The MOS is the means by which the analysis accounts for the uncertainty about the relationship between pollutant loads and the receiving water quality (EPA, 2001). The MOS can be expressed explicitly by setting aside a portion of the allowable load in reserve or implicitly through the use of conservative analytical assumptions. For this present study the MOS has been included implicitly through use of conservative assumptions. The following are factors that contribute to the implicit margin of safety supporting the FC targets:

- In the analysis for determining the reduction needed in bacteria loads to meet water quality standards, the most critical two or three month loading period was used. Any management activities implemented to abate FC loads would be protective throughout the year.

- With the statistical rollback method, a 90^{th} percentile is calculated that is more conservative than the class A water quality criteria. The method uses the variability of the FC distribution at each site to generate the 90^{th} percentiles.

- Target loads and loading calculations did not incorporate a die-off rate for bacteria.

- Discharge was 27% greater than the average period of record for the Kettle Falls gaging station. This may have generated higher than normal FC loads.

Follow-up Monitoring and Evaluation

Another required component of the TMDL process is follow-up monitoring and evaluation. Because of the uncertainty between the relationship of management activities and waterbody response, follow-up monitoring is necessary to assess the adequacy of control actions. Results from follow-up monitoring will guide future control actions and needed revisions to the TMDL. The goal of follow-up monitoring is to assure management measures are successful and protective of primary and secondary contact recreation such as swimming and fishing.

A monitoring program is recommended for follow-up evaluations using the established monitoring stations developed and sampled by the Stevens County Conservation District and Ecology for the TMDL study. Because of the land holdings along the river, limited access points are available. High priority sites in the upper basin should be targeted first for management activities for the potential benefits to downstream reaches. During the dry season, at a number of locations in the upper basin, cattle were observed directly accessing streams. Fecal coliform data from this study clearly show a bacteria problem during the dry season. The monitoring program should focus efforts during the dry period, from May through October. Due to the frozen conditions that last much of the winter, only limited wet weather sampling should be conducted, to reserve resources for dry season sampling. The Stevens County Conservation District should be supported with grants to continue the monitoring program on a weekly to every-other-week schedule through the dry season.

Monitoring results should be reviewed regularly, or at the conclusion of the sample season, to evaluate if targets have been met or adjustments in the TMDL need to be made. If farm plans are developed, which include installing BMPs, implementation monitoring could be used as a demonstration project.

Monitoring in the Colville River basin should continue to focus on FC as the compliance standard for the TMDL. With the possibility of a change in the state's bacteria standard

(WQP, 1999), concurrent analysis for E. coli should be considered. If E. coli is chosen as the new bacteria standard, concurrent sampling should take place until correlations between the two are developed and TMDL targets calculated for E. coli are completed.

An evaluation of TMDL monitoring results should be conducted yearly, following dry season sampling and implementation of control measures. Data from the Stevens County Conservation District, Ecology, and others need to be evaluated – along with information on implementation measures, farm plans, and any other pertinent land-use or water quality information. If water quality data are found to be inadequate for evaluation of the TMDL, the Ecology Eastern Regional Office should request additional monitoring or give support to local resource managers to do monitoring.

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Conclusions and Recommendations

- Further investigation is needed in the Colville River sub-watersheds and along the riparian corridor of the Colville River to develop site-specific prescriptions for abatement measures.

- Farm plans should be developed for locations where sources are identified.

- Throughout the study, the most obvious source of bacteria inputs was from cattle directly accessing the streams. Grants and cost-share loans should be supported for implementation of fencing and watering facilities.

- The area upstream and downstream of the Colville River at Betteridge Road sample site (CR4) should be evaluated as a priority for corrective action. During the dry season, cattle were often observed accessing the river. The CR4 site was identified as needing the highest percent reduction (89%) of bacteria to meet water quality standards for mainstem sites. The next downstream site, Colville River at Waitts Lake Road (CR6), is likely being impacted by activities in the Betteridge Road area. The CR6 site has the second largest reduction target (84%) to meet standards.

- All river segments and tributaries in the study require bacteria reductions during the dry season. The level of target bacteria reduction needed varies widely from 3% to 95%.

- All mainstem segments had higher bacteria loads than tributaries. Haller Creek had the highest load for tributaries, and was assigned a 95% reduction target to meet standards.

- When setting priorities for corrective actions, a ranking matrix should be used that includes issues such as: degree of standard exceedance, bacteria load, 303(d) listing, recreational potential, local interest, public access, and fish use and species.

- The Colville and Chewelah wastewater treatment plants were not included in the study or TMDL targets. Recent upgrades and permit issuance should maintain compliance with the water quality standards and be protective of the water resource. The required monitoring reports for the plants should be reviewed annually to assure the new permits are not being violated. If monitoring results determine permits are being violated, the TMDL may need to be re-evaluated and targets adjusted to include the WWTPs.

- A long-term monitoring program for the basin should be developed and supported. The effectiveness of pollution controls need to be followed to assure compliance with TMDL targets. It can take years for corrective actions to become fully effective in areas that are dominated by nonpoint sources of pollution.

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Appendices

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Appendix A

Figures

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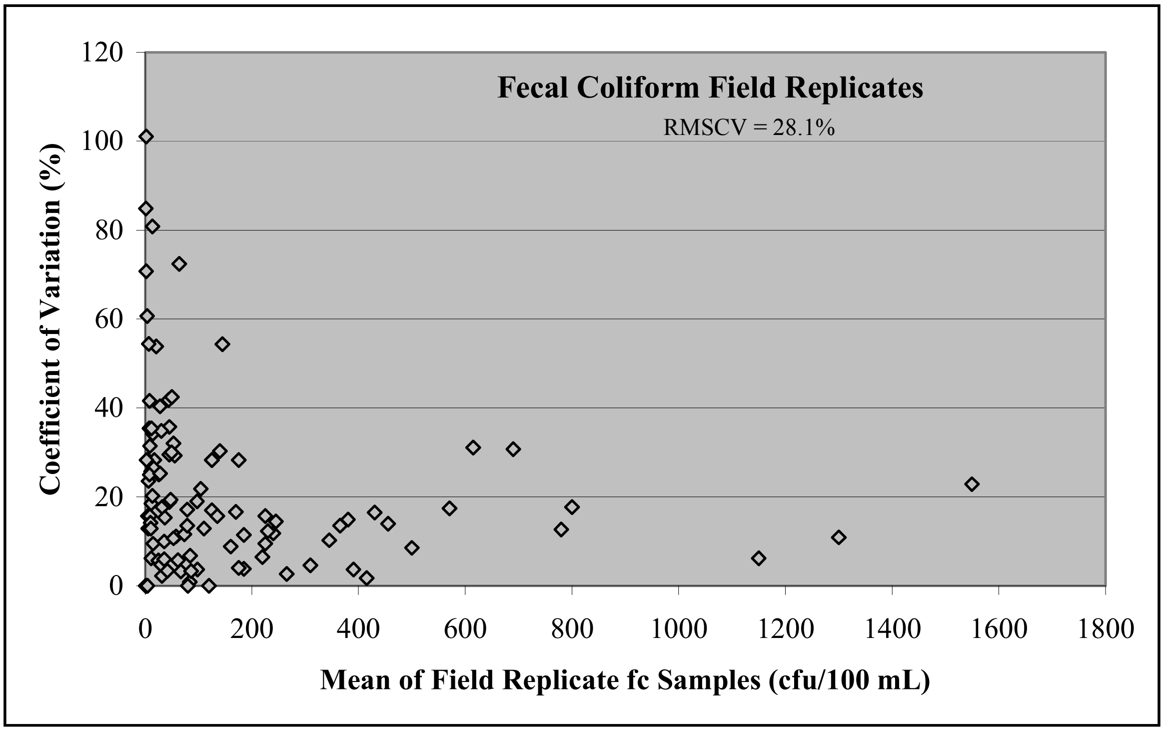


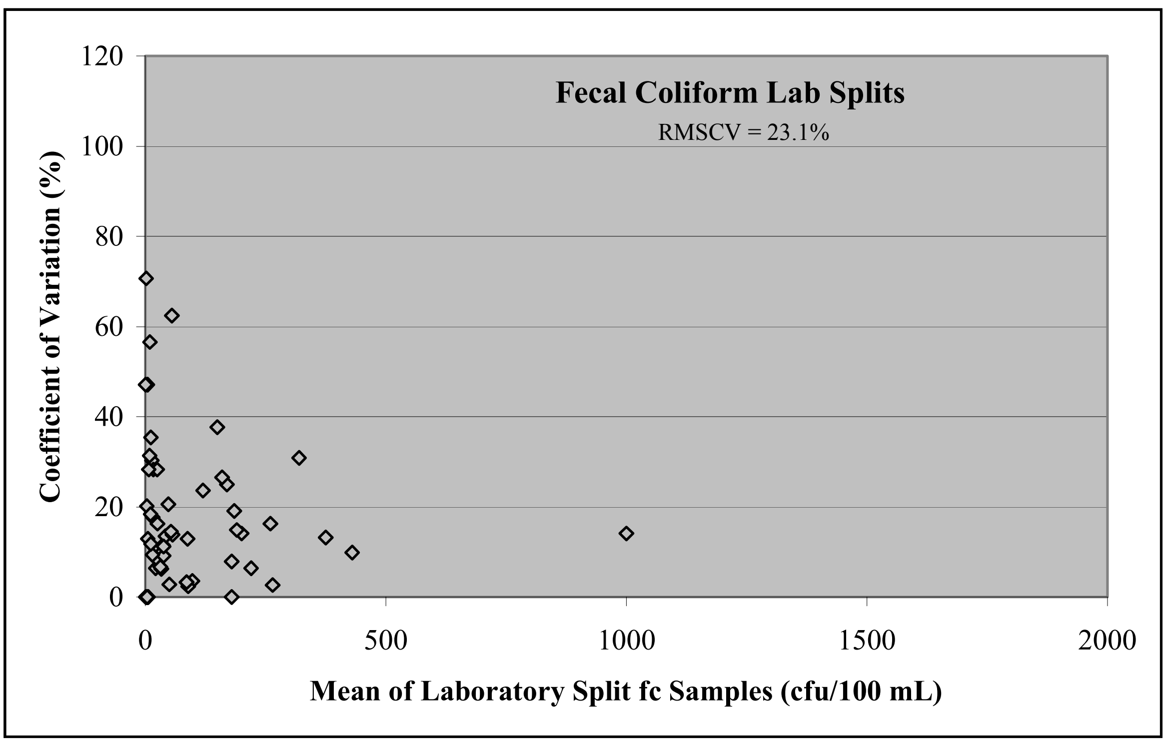
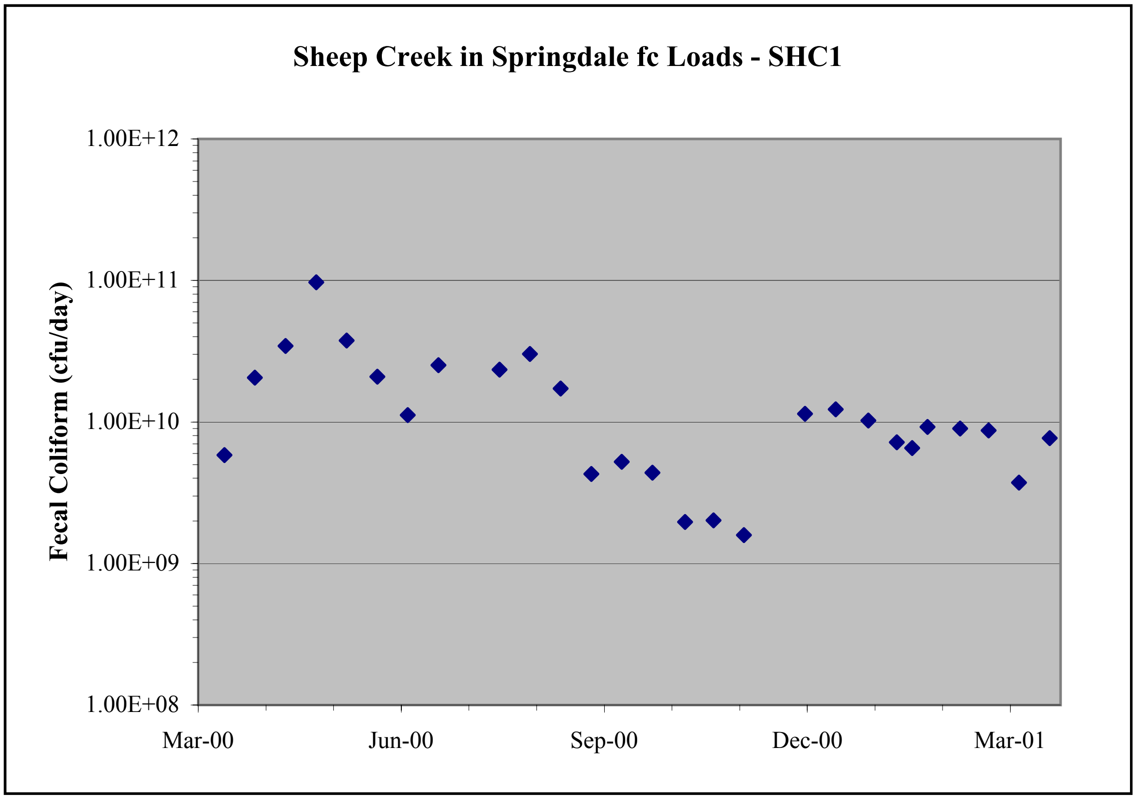


Figure A1. Coefficient of variation for fecal coliform field replicates and lab splits.



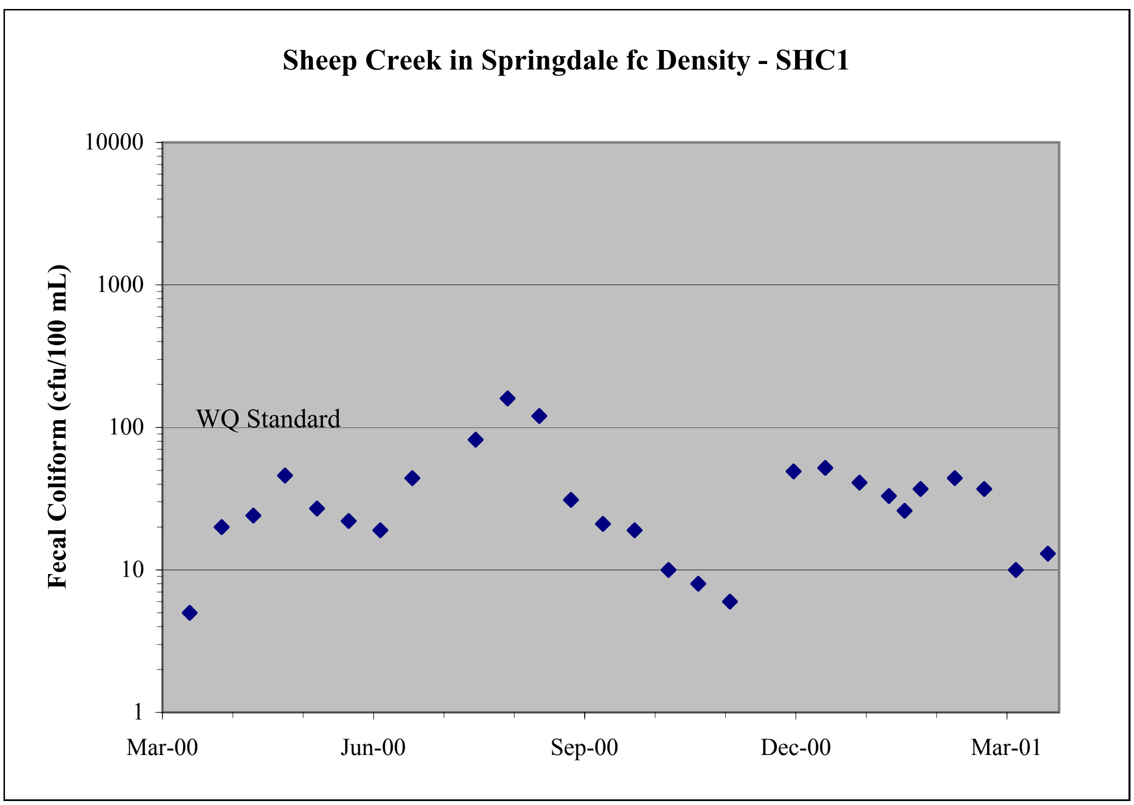
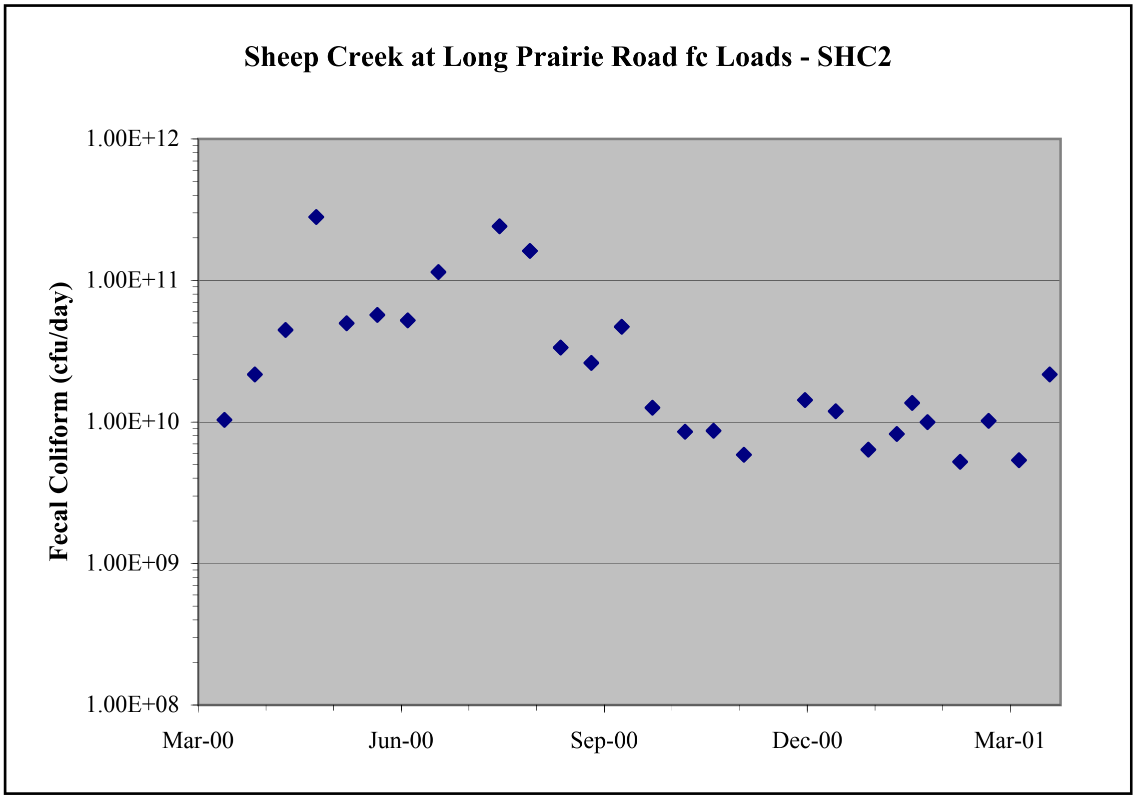


Figure A2. Sample day bacteria density and load for the SHC1 site.



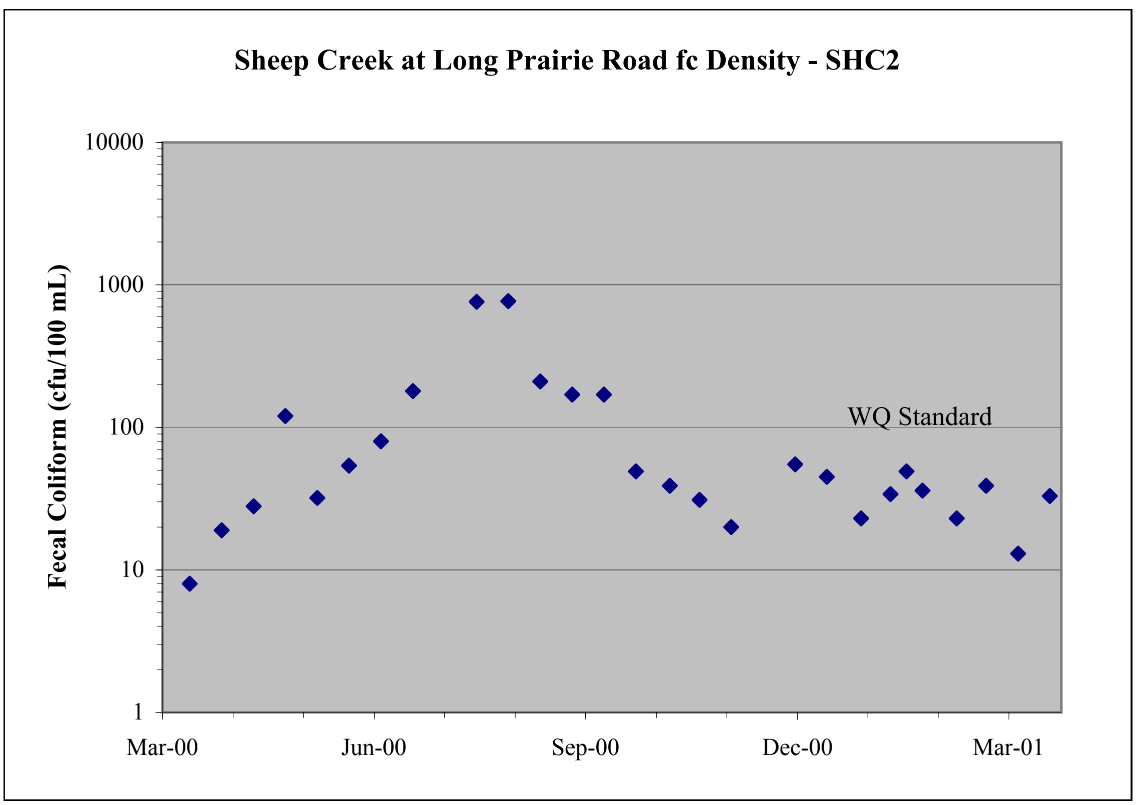
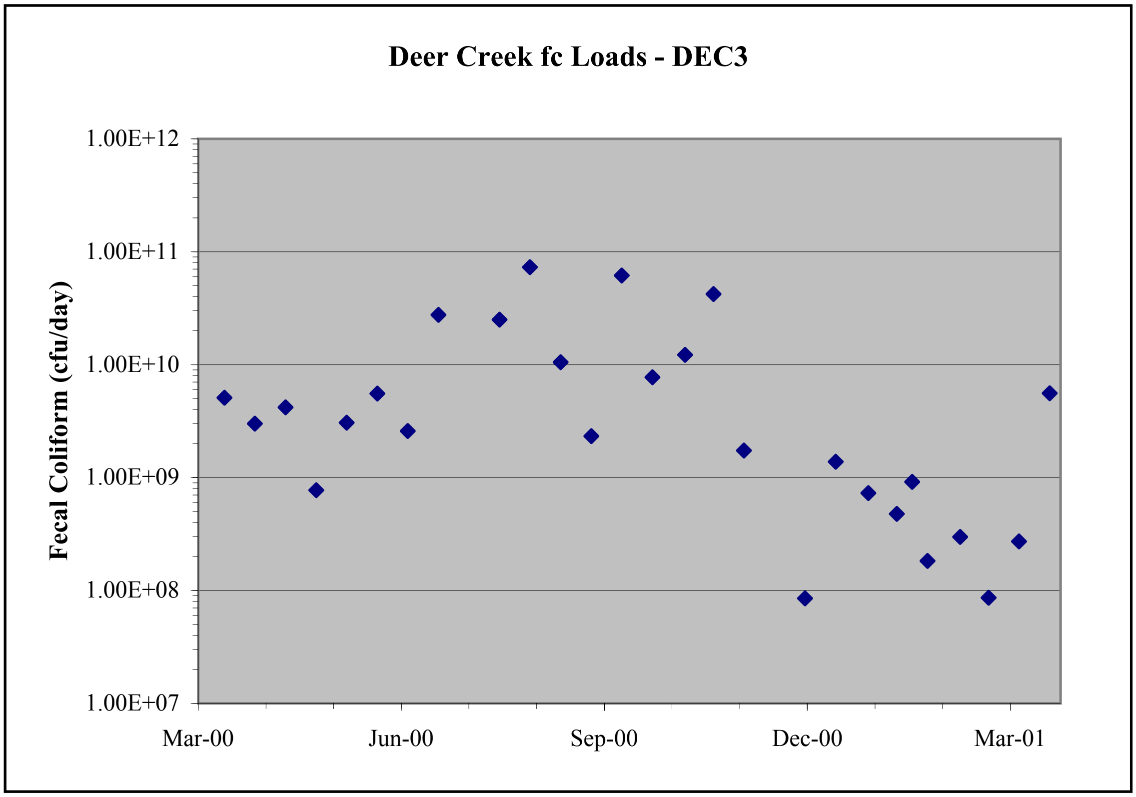


Figure A3. Sample day bacteria density and load for the SHC2 site.



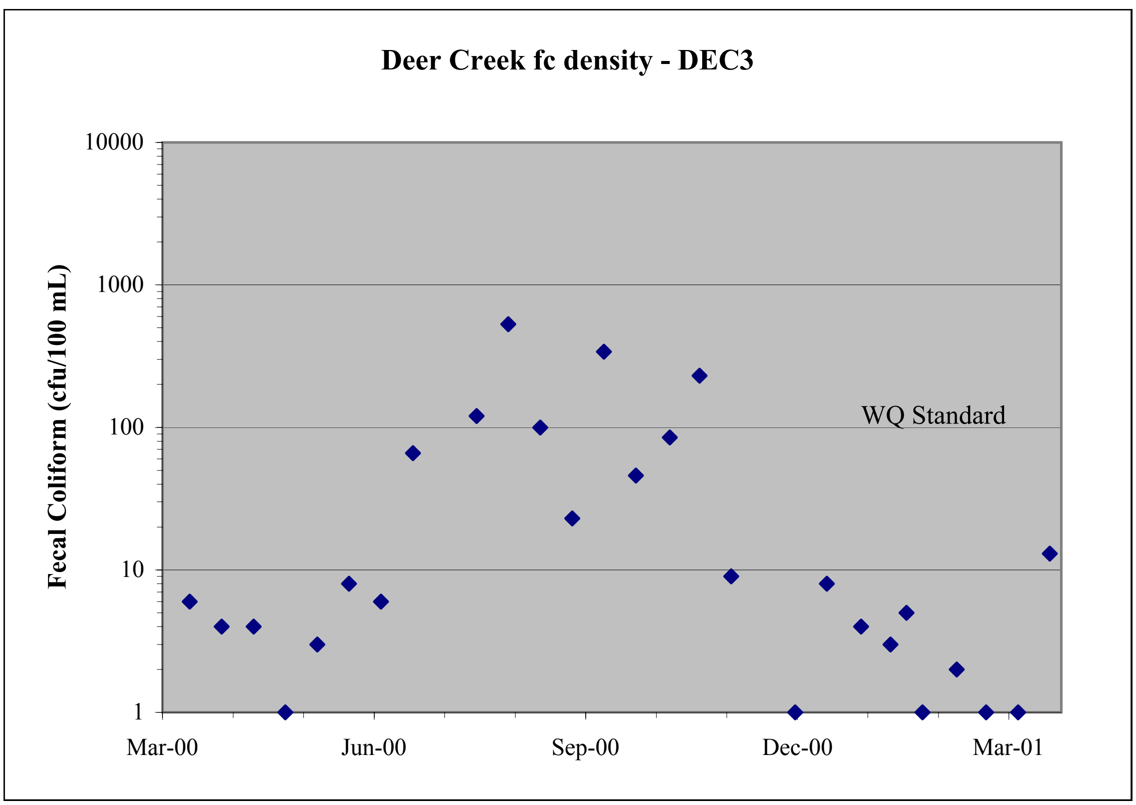
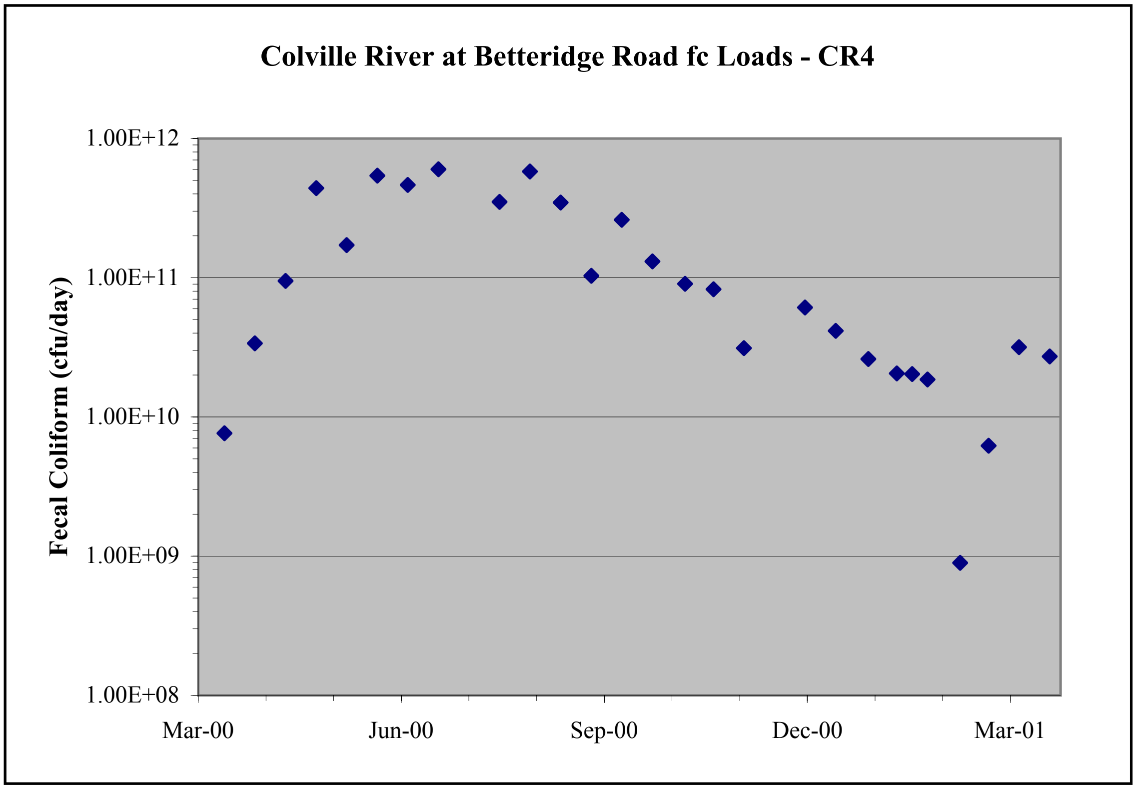


Figure A4. Sample day bacteria density and loads for the DEC3 site.



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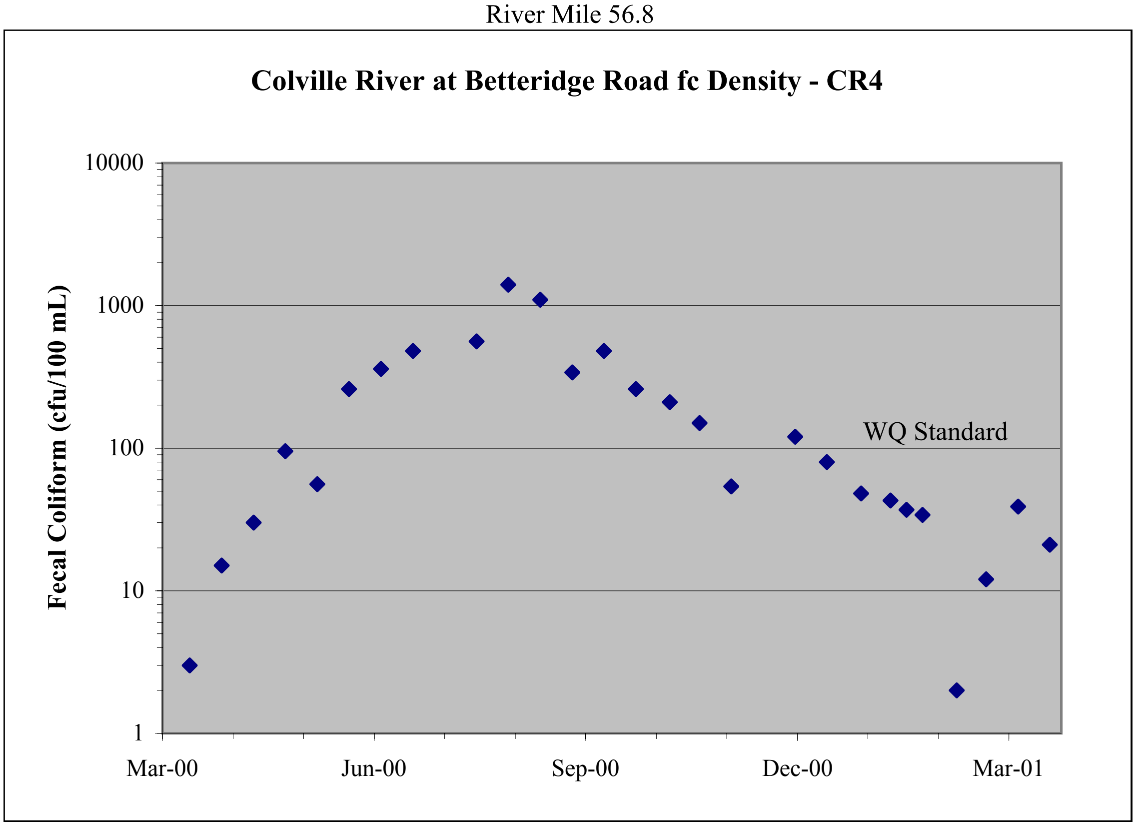
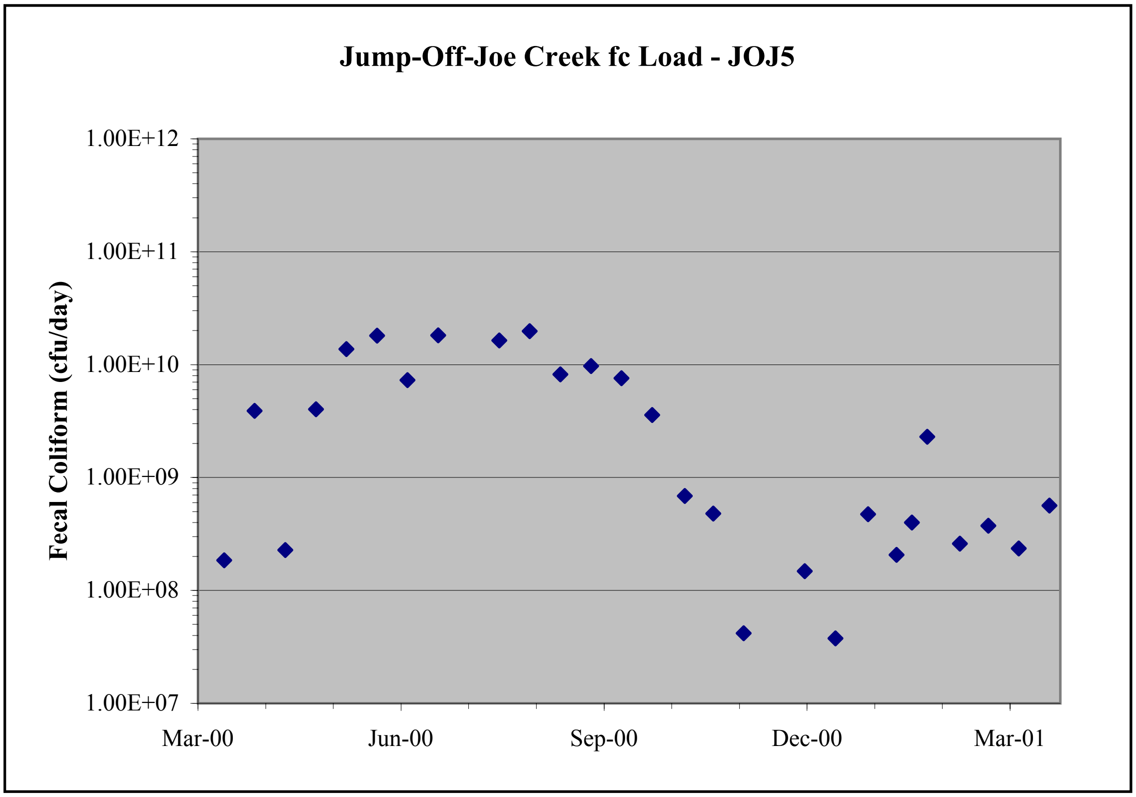


Figure A5. Sample day bacteria density and loads for the CR4 site.



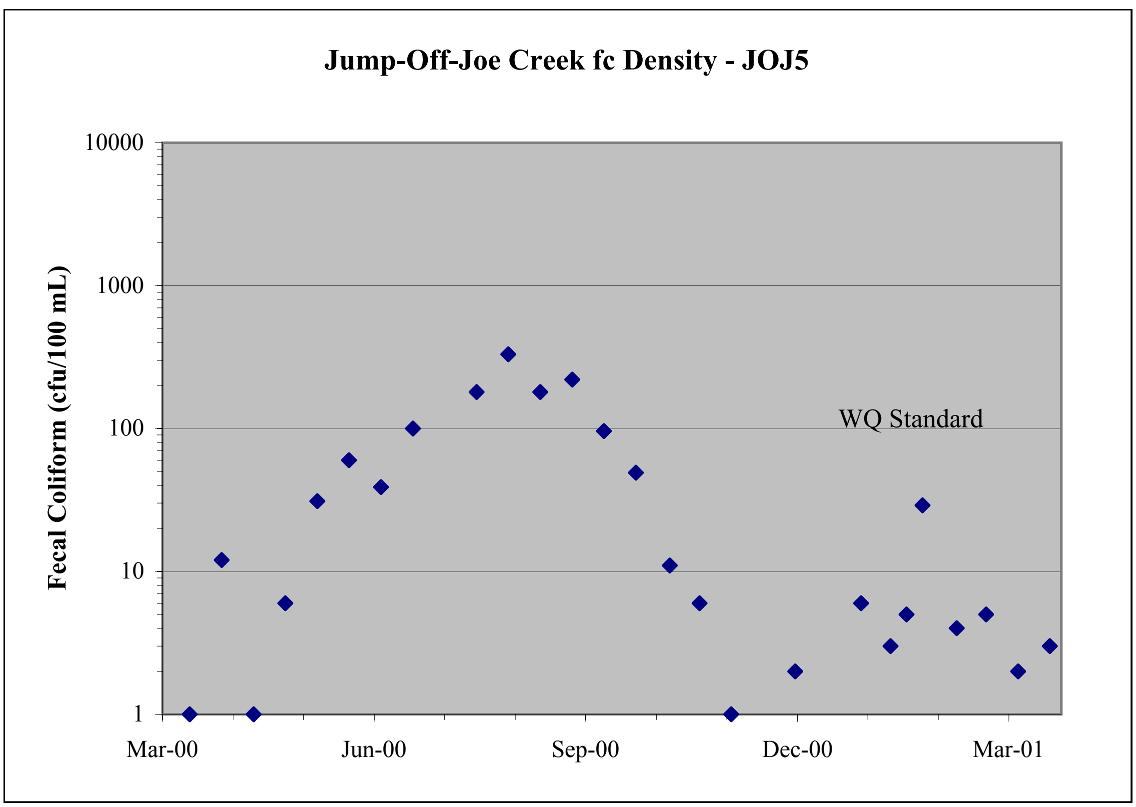
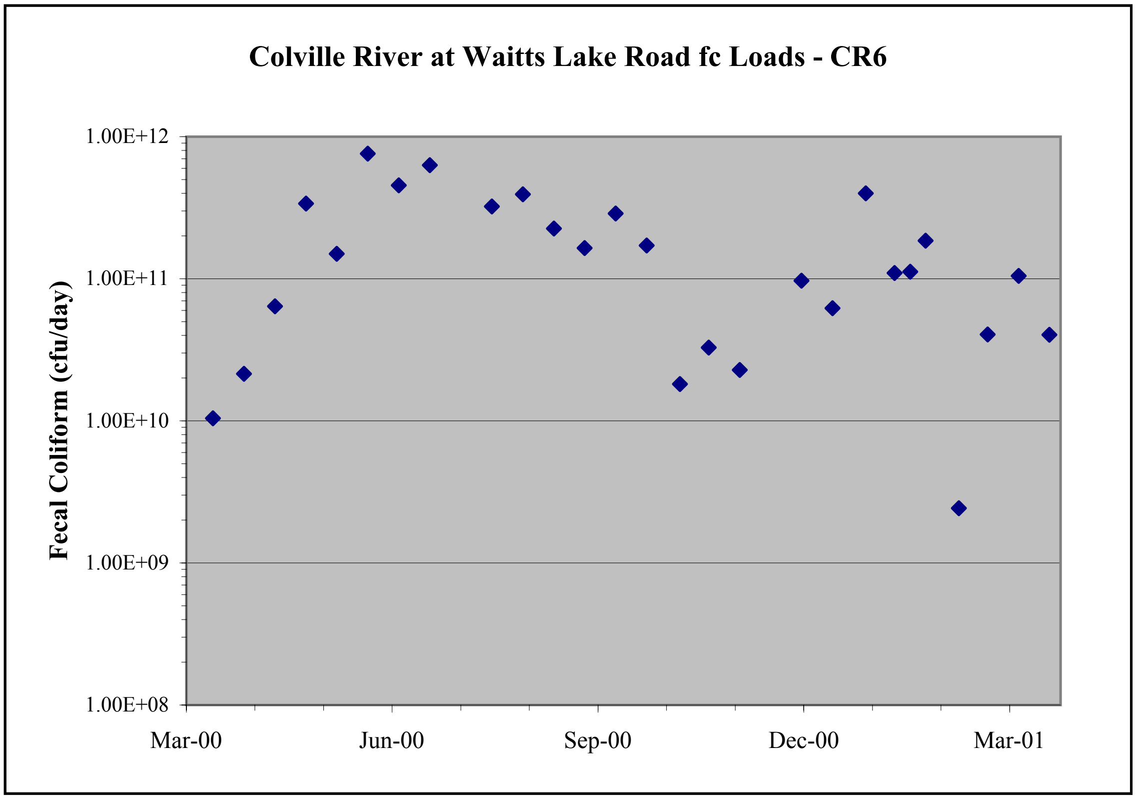


Figure A6. Sample day bacteria density and loads for the JOJ5 site.



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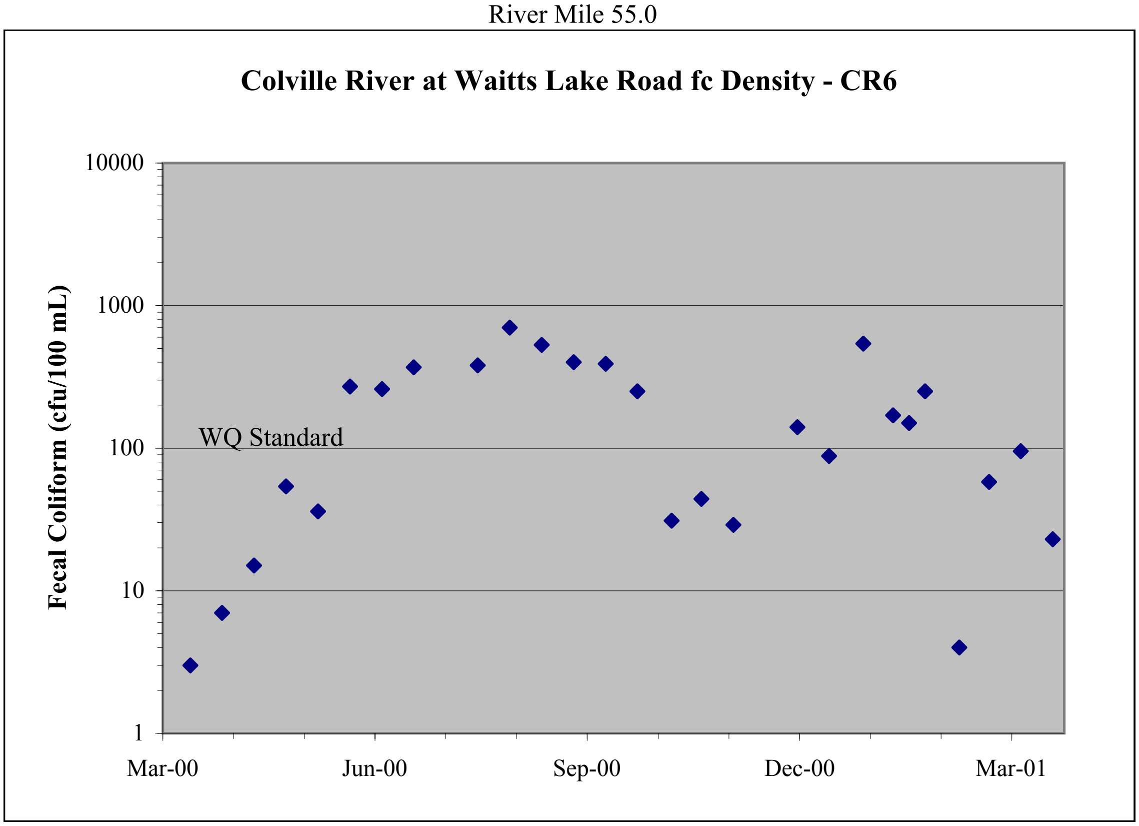
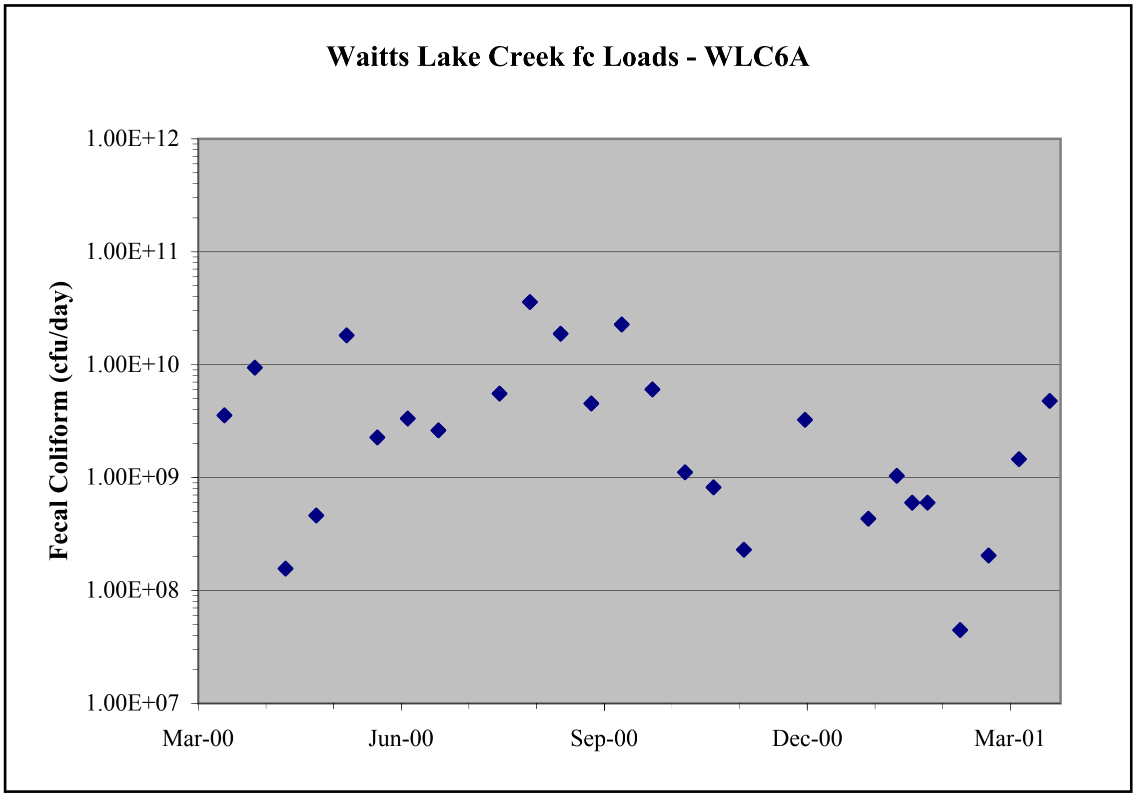


Figure A7. Sample day bacteria density and loads for the CR6 site.



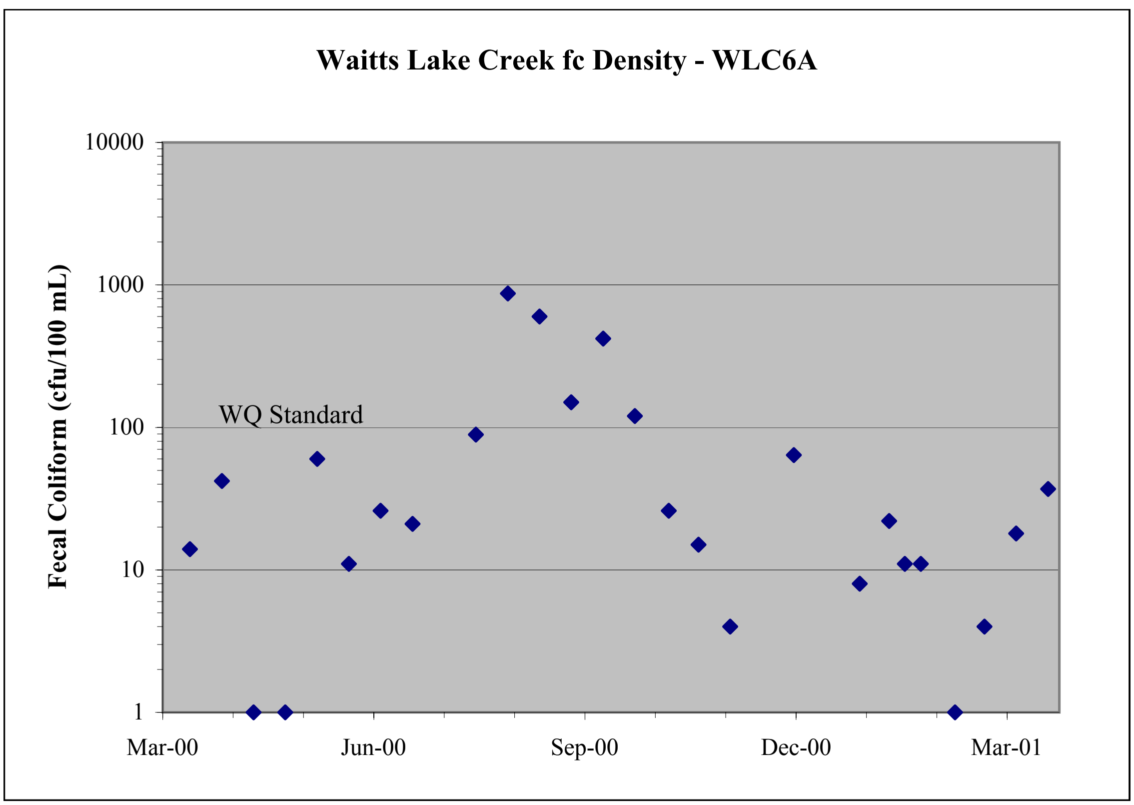
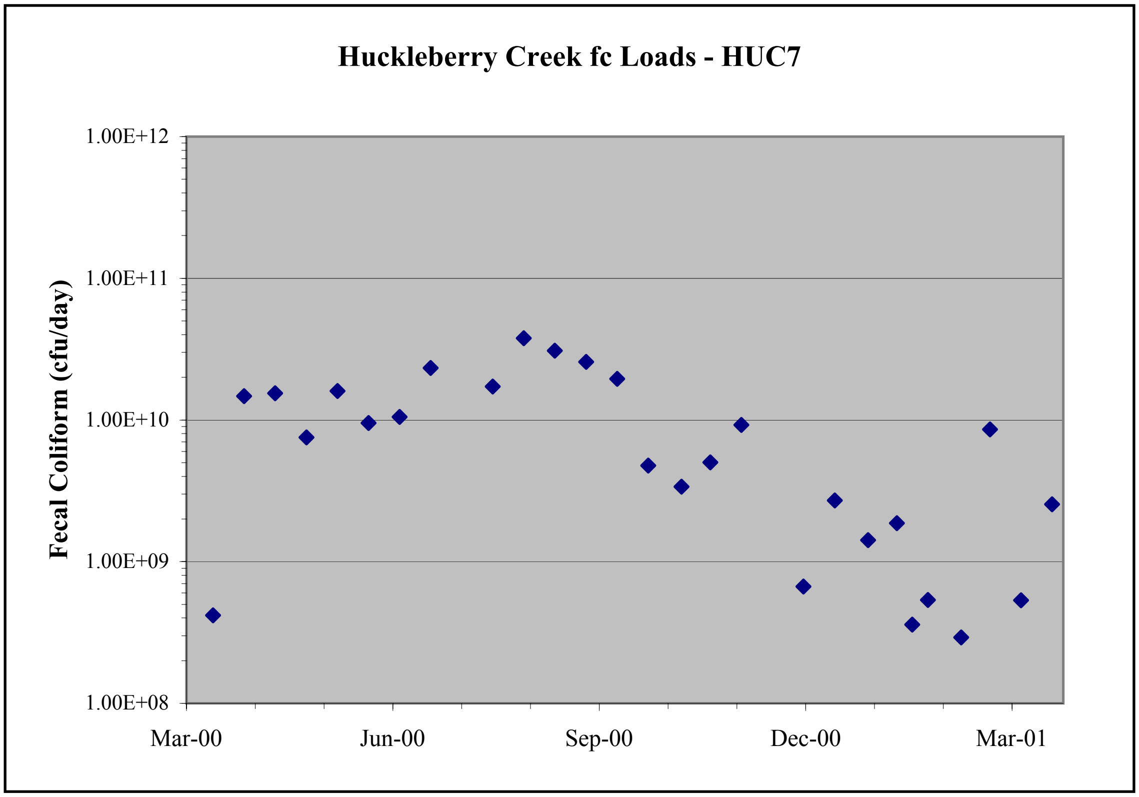


Figure A8. Sample day bacteria density and loads for the WLC6A site.



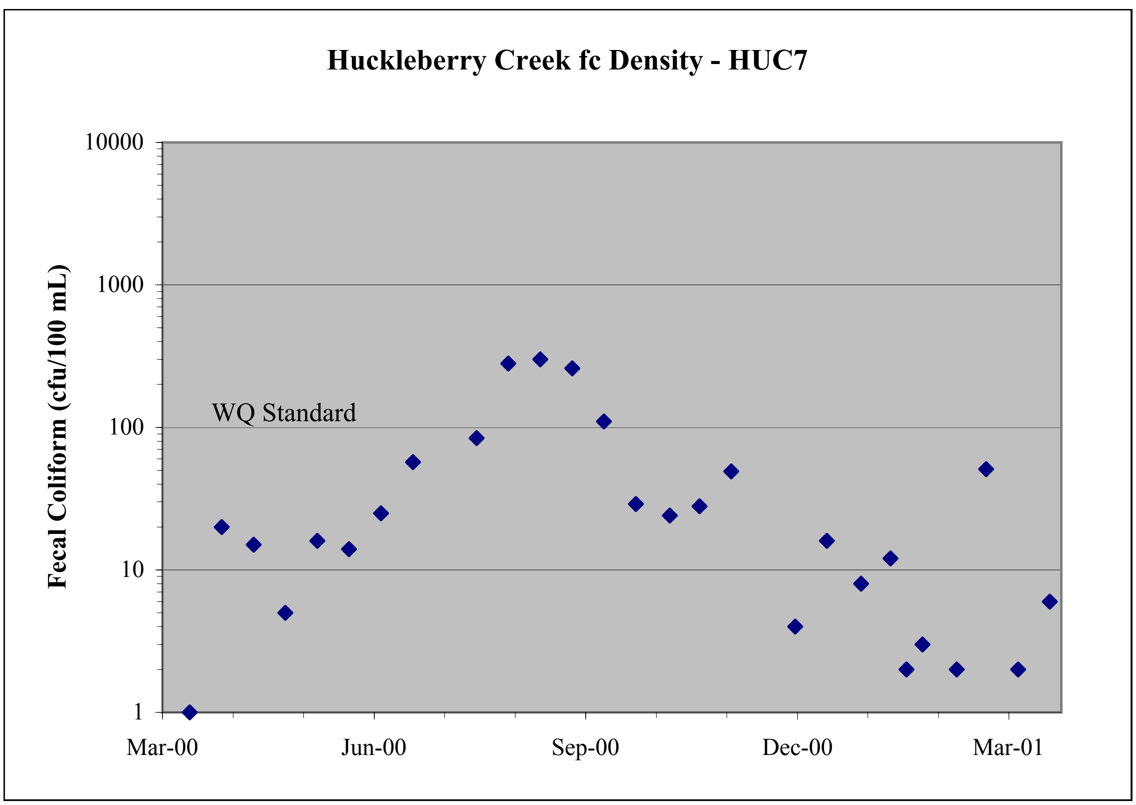
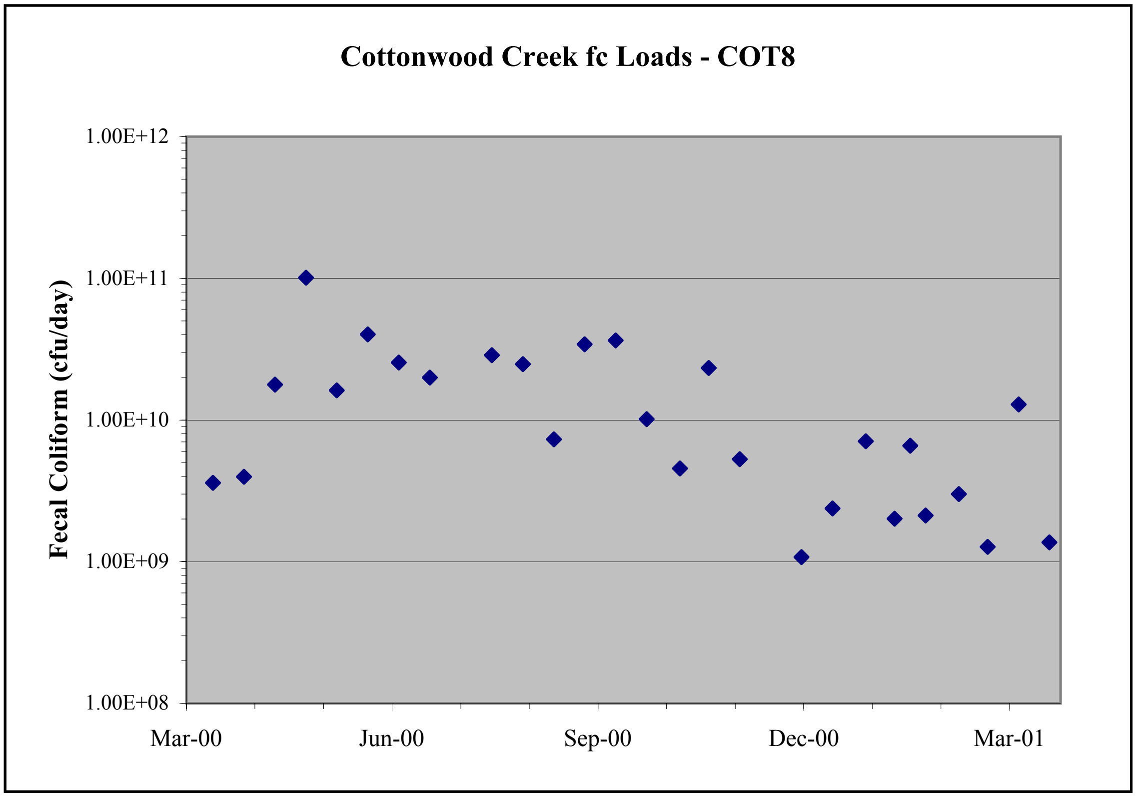


Figure A9. Sample day bacteria density and loads for the HUC7site.



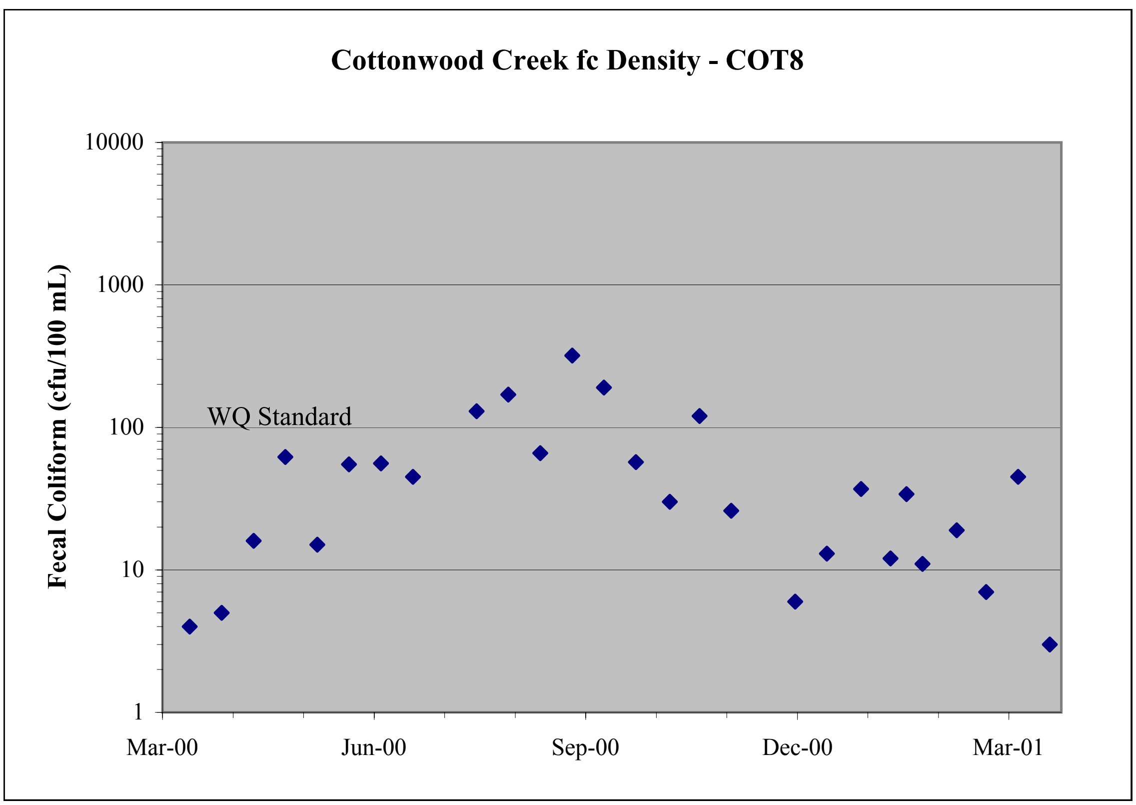
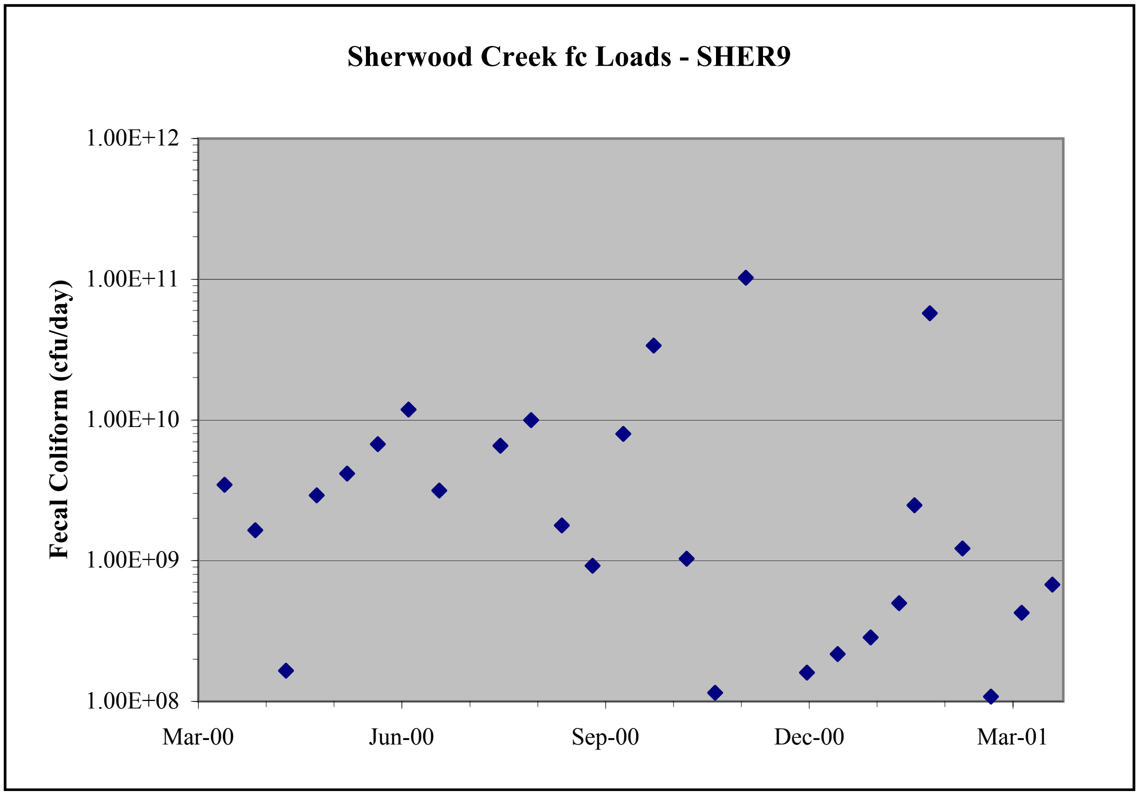


Figure A10. Sample day bacteria density and loads for the COT8 site.



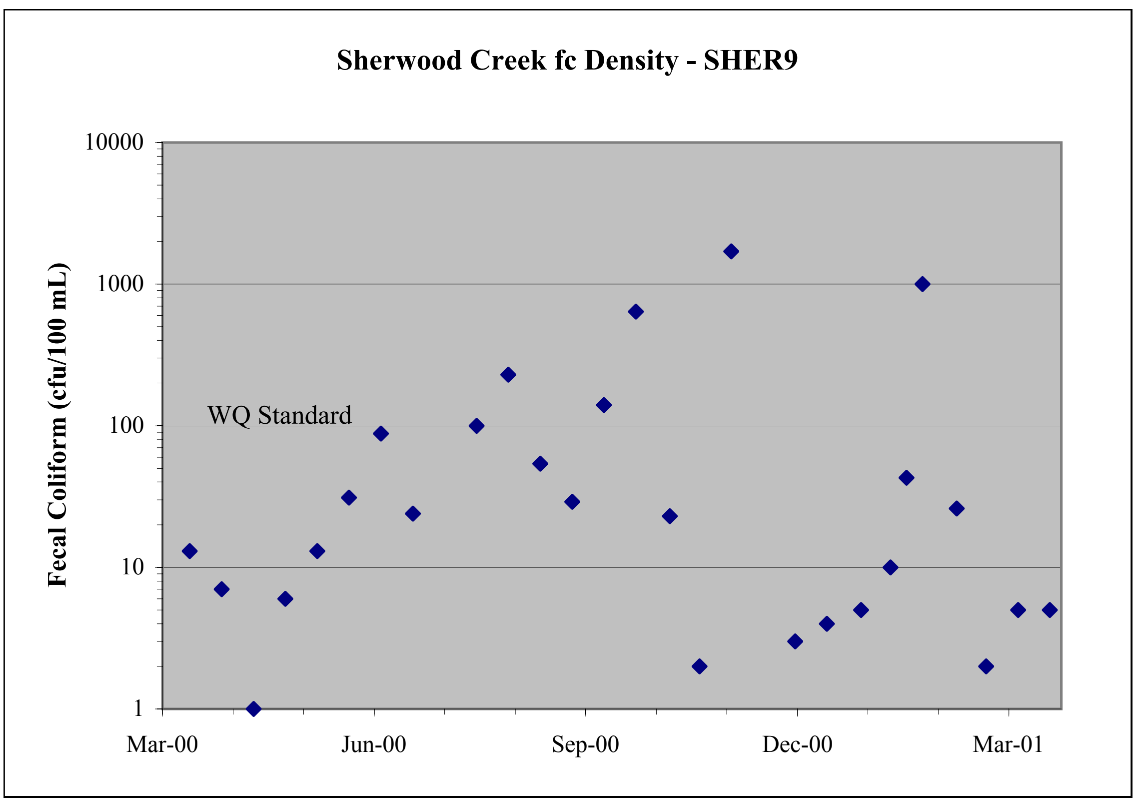
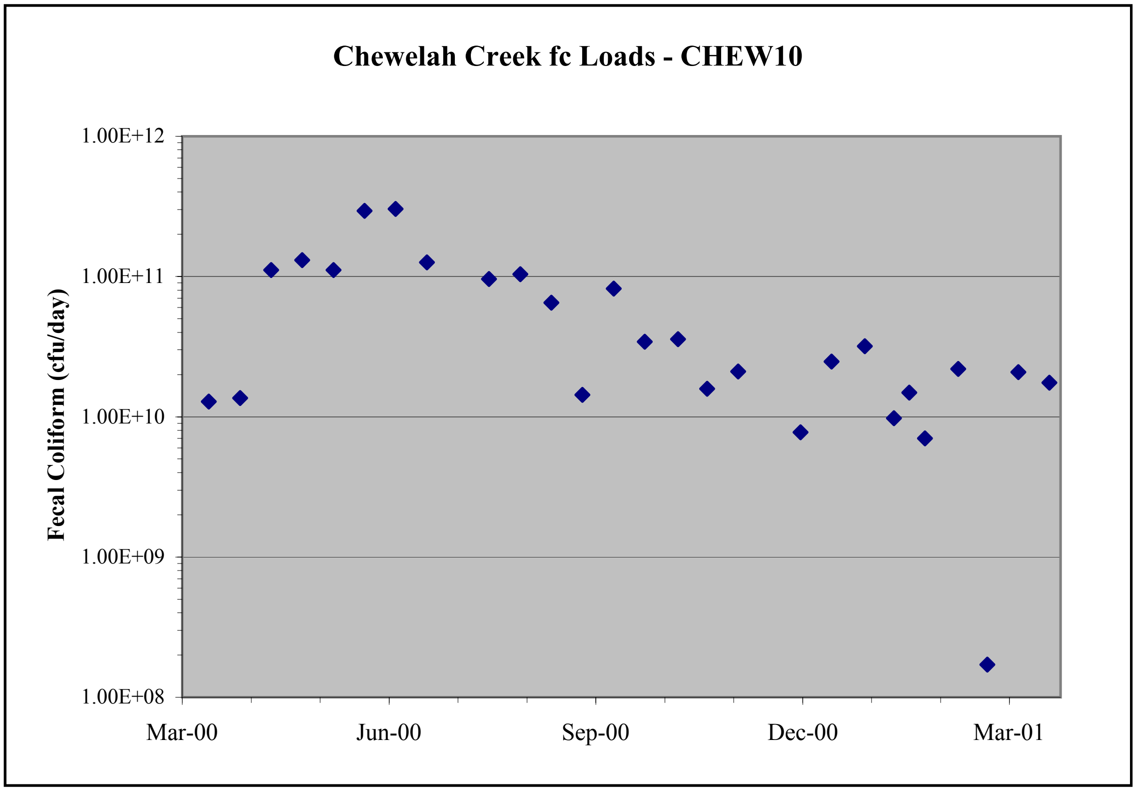


Figure A11. Sample day bacteria density and loads for the SHER9 site.



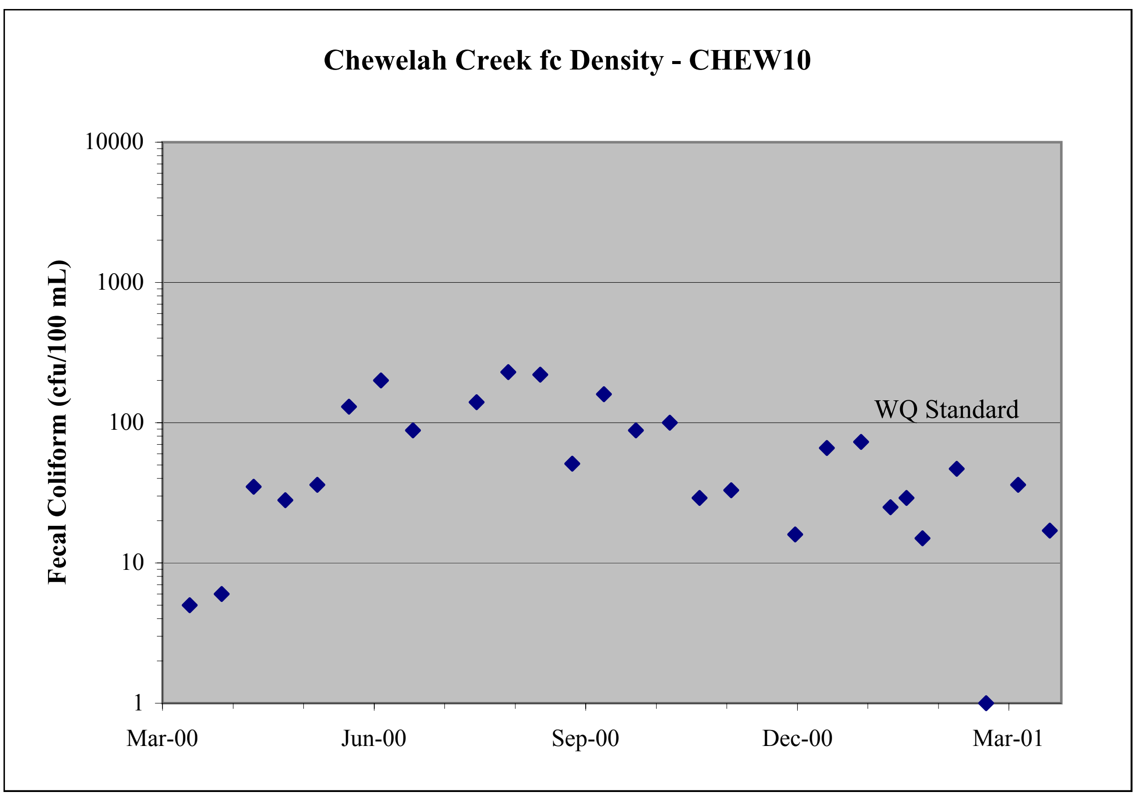
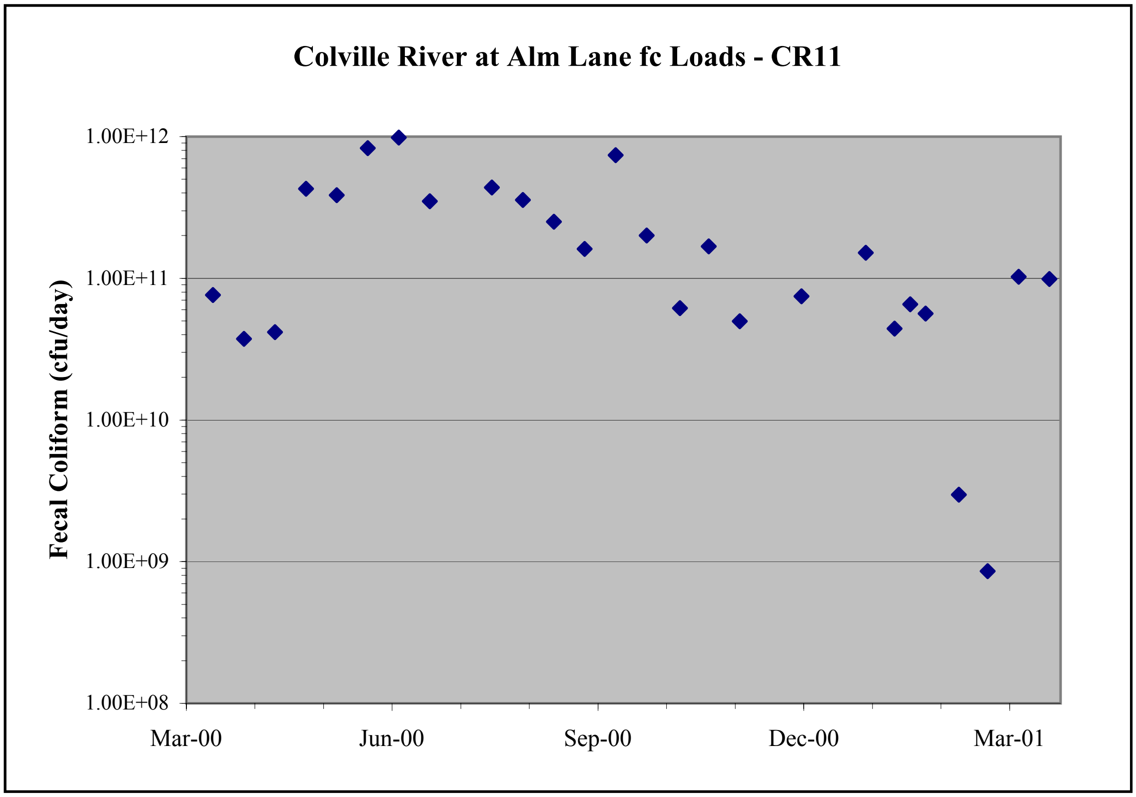


Figure A12. Sample day bacteria density and loads for the CHEW10 site.



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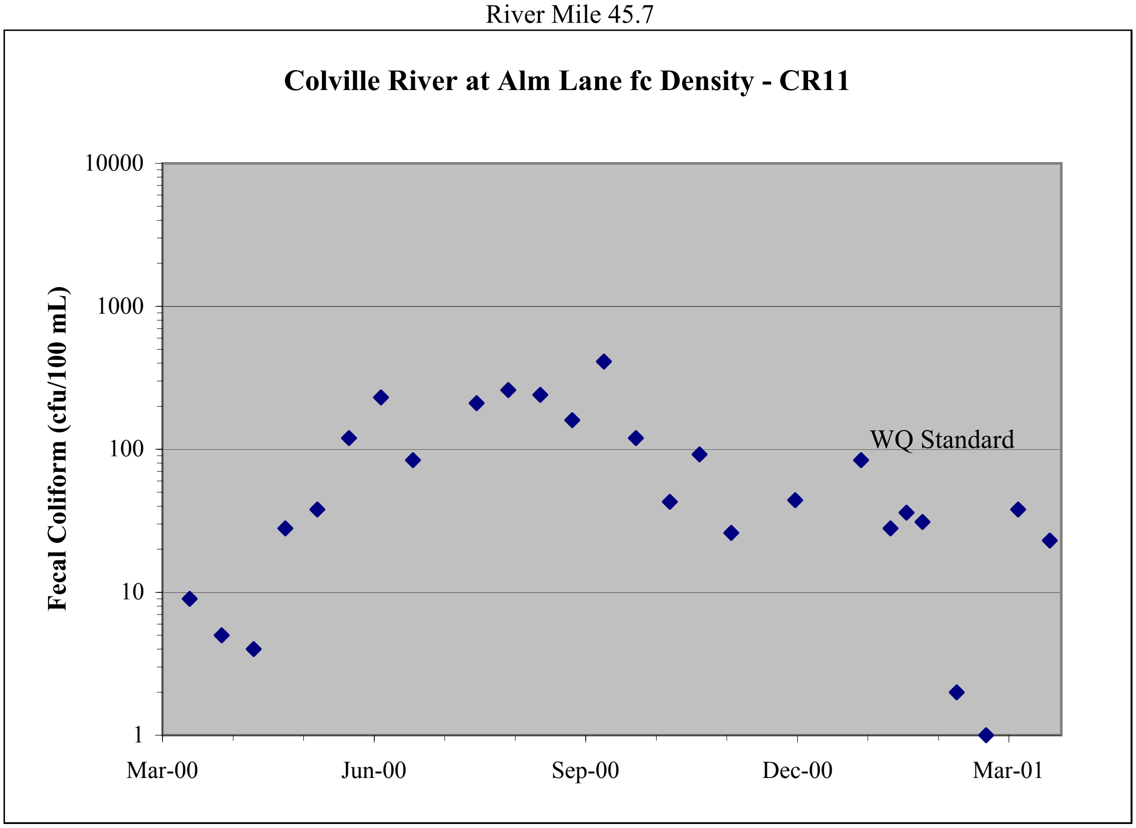
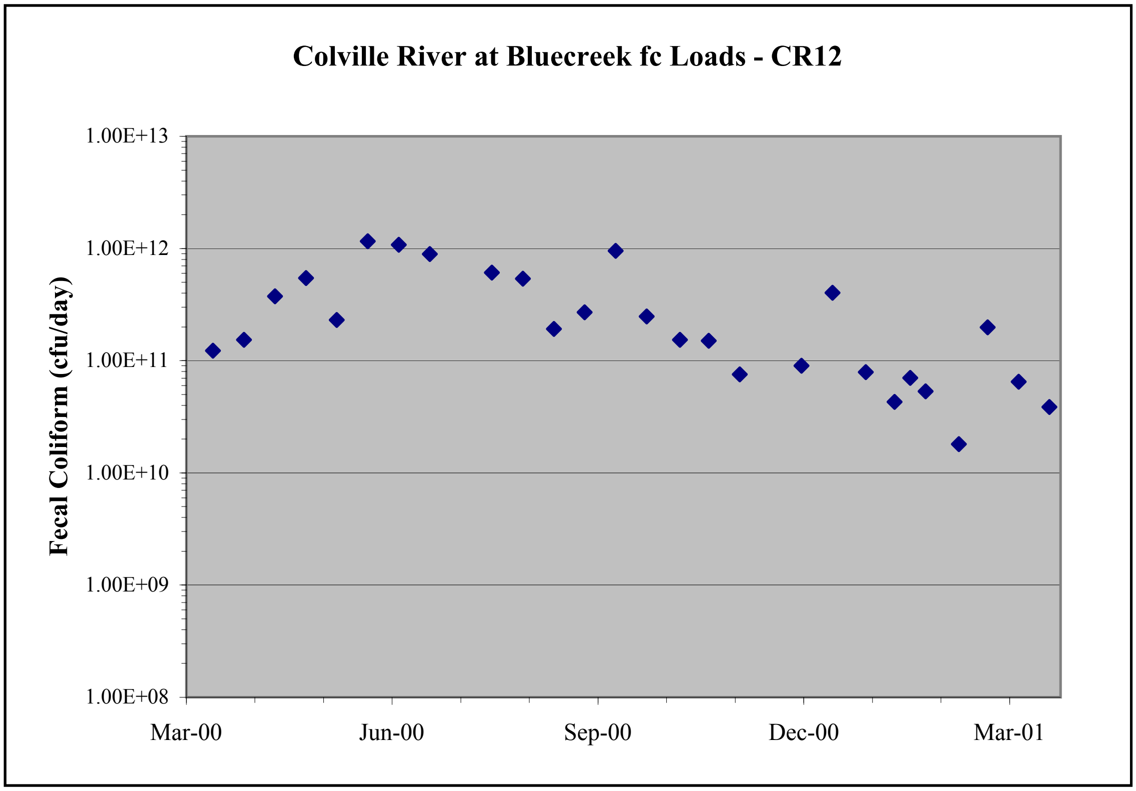


Figure A13. Sample day bacteria density and loads for the CR11 site.



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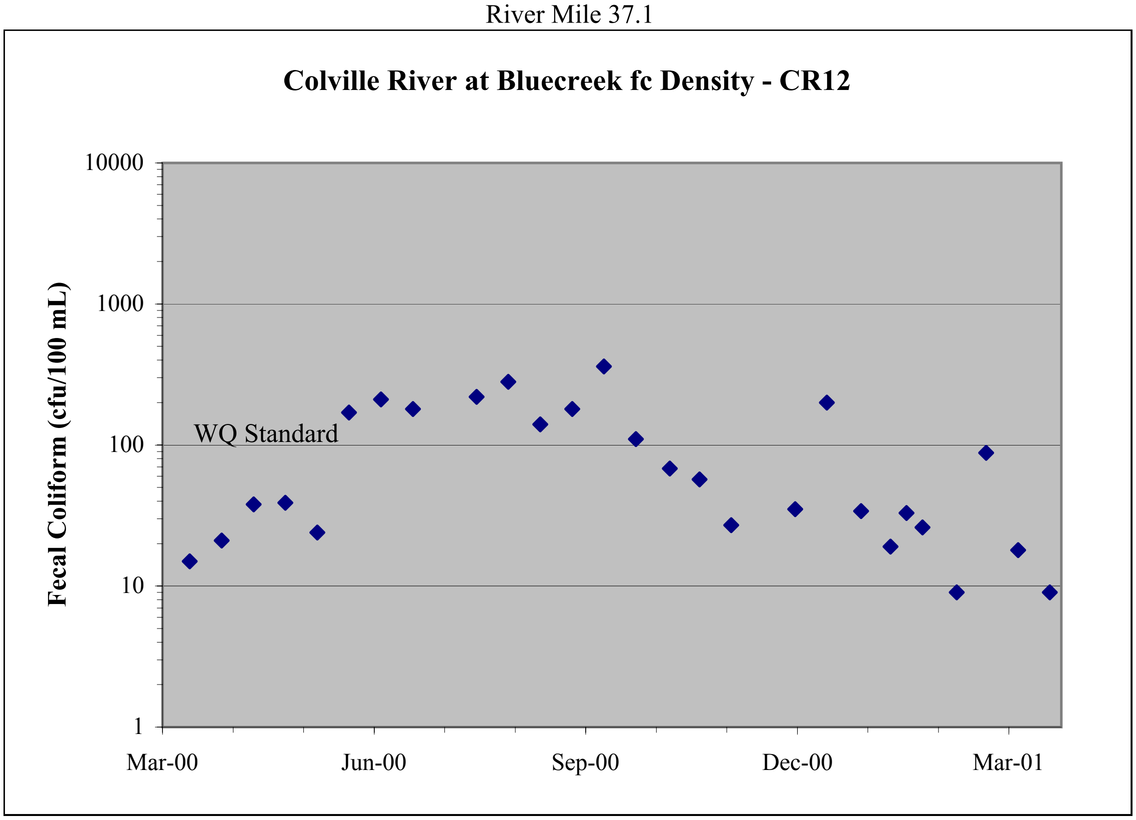
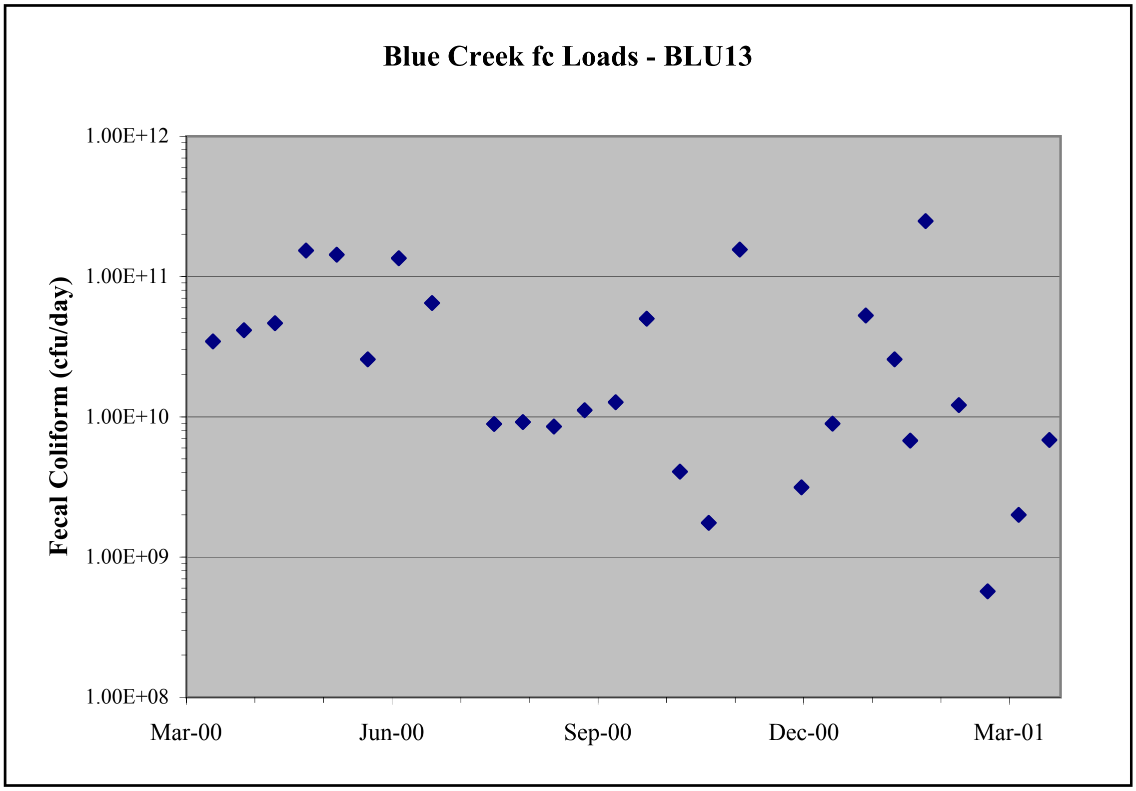


Figure A14. Sample day bacteria density and loads for the CR12 site.



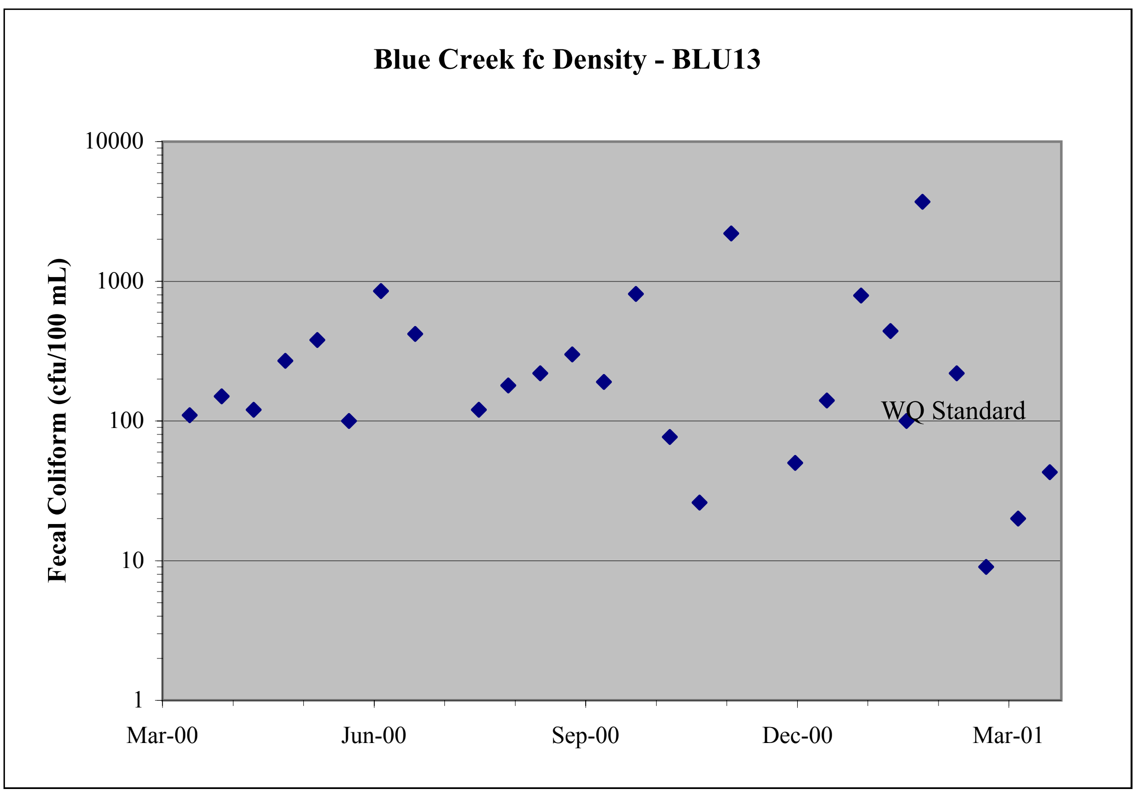
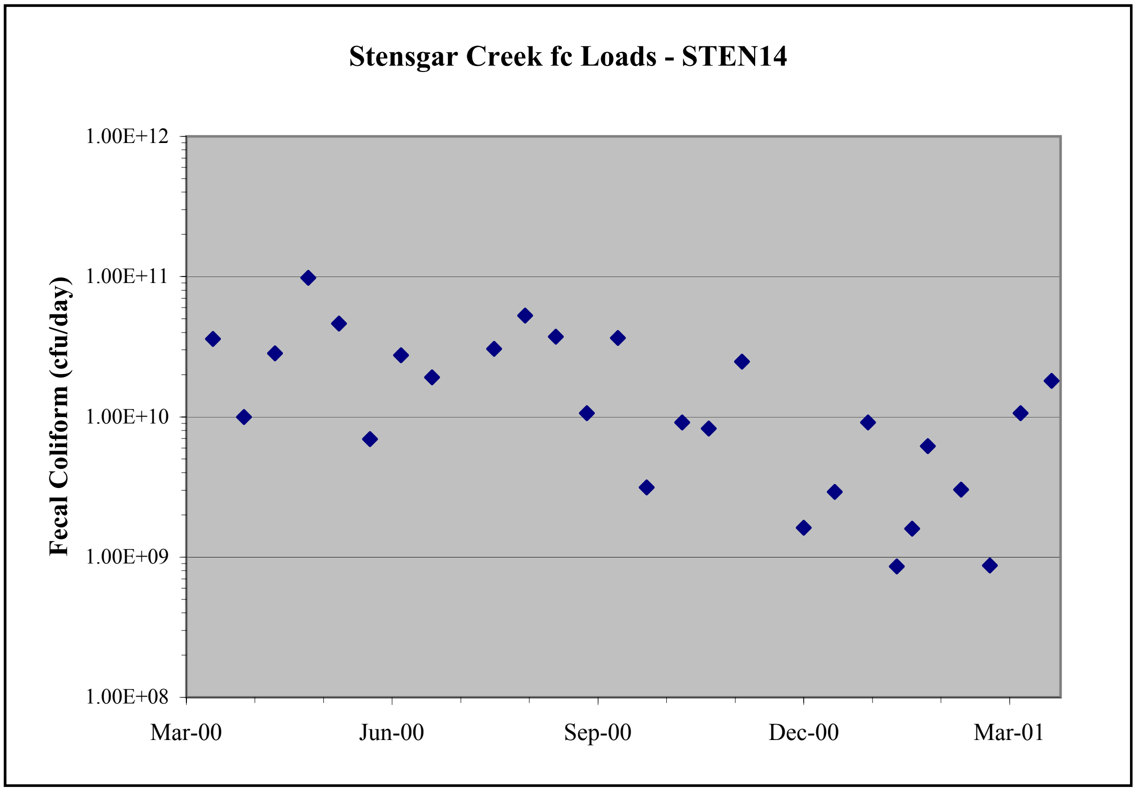


Figure A15. Sample day bacteria density and loads for the BLU13 site.



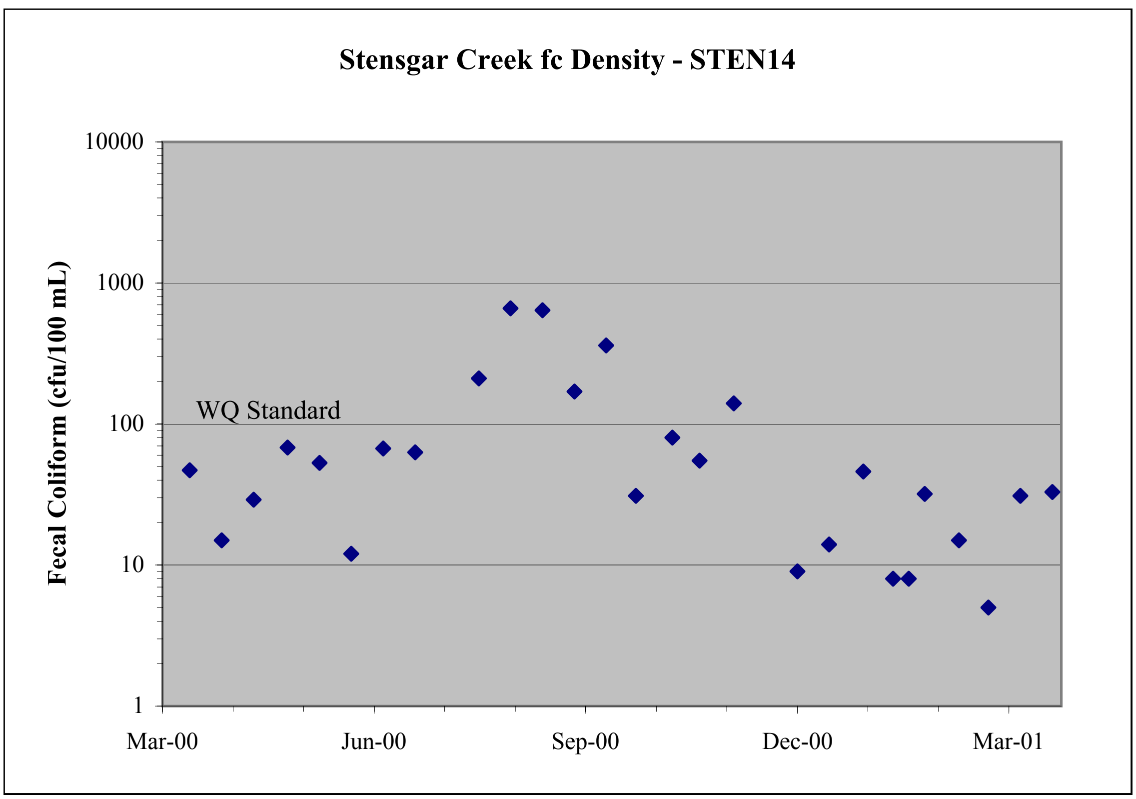
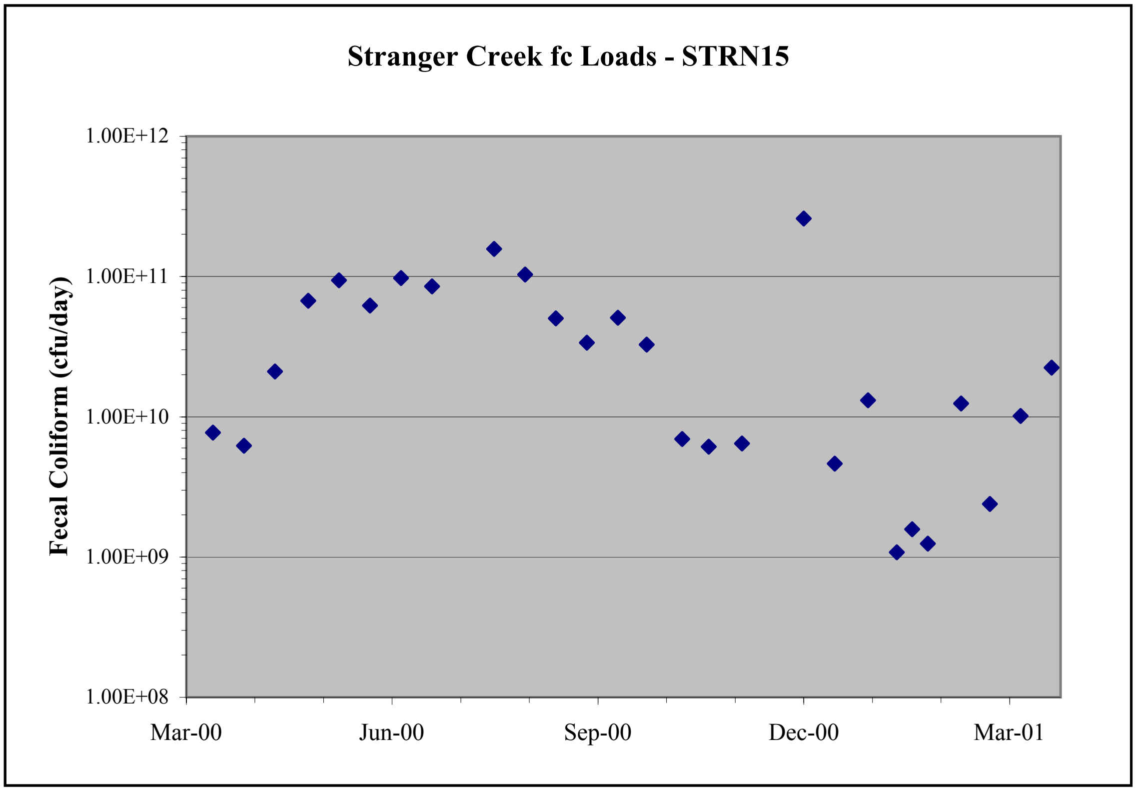


Figure A16. Sample day bacteria density and loads for the STEN14 site.



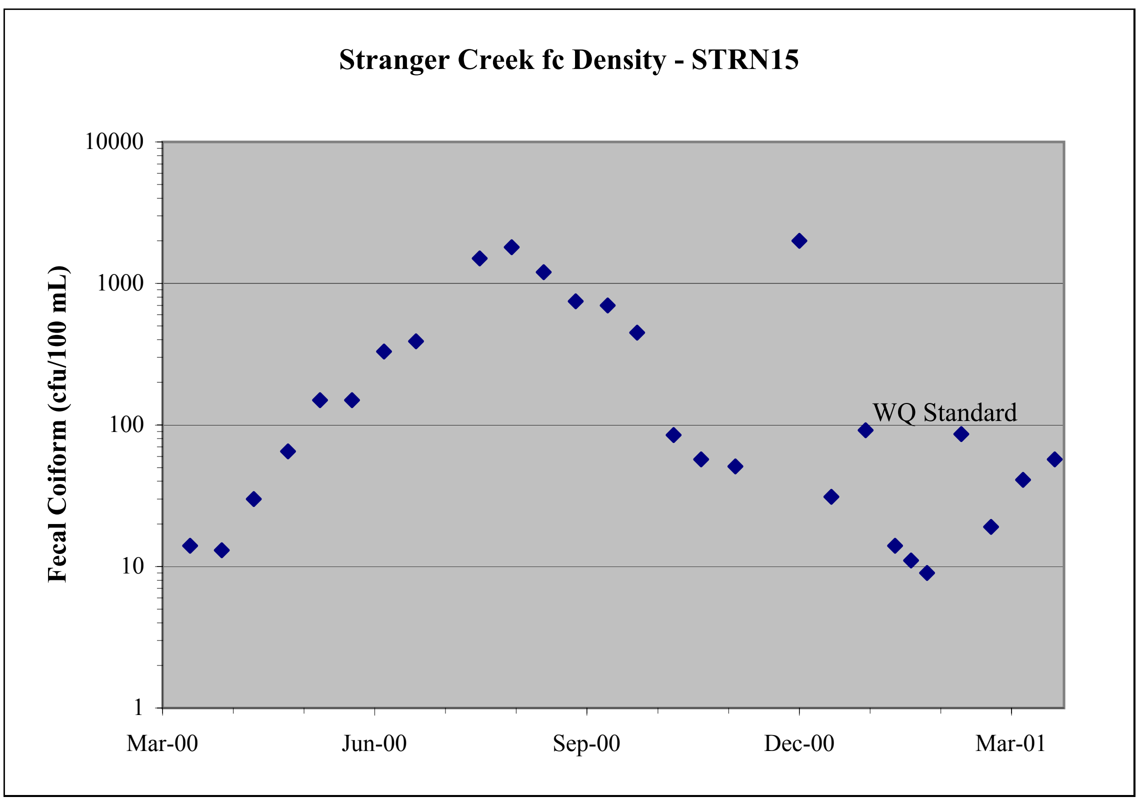
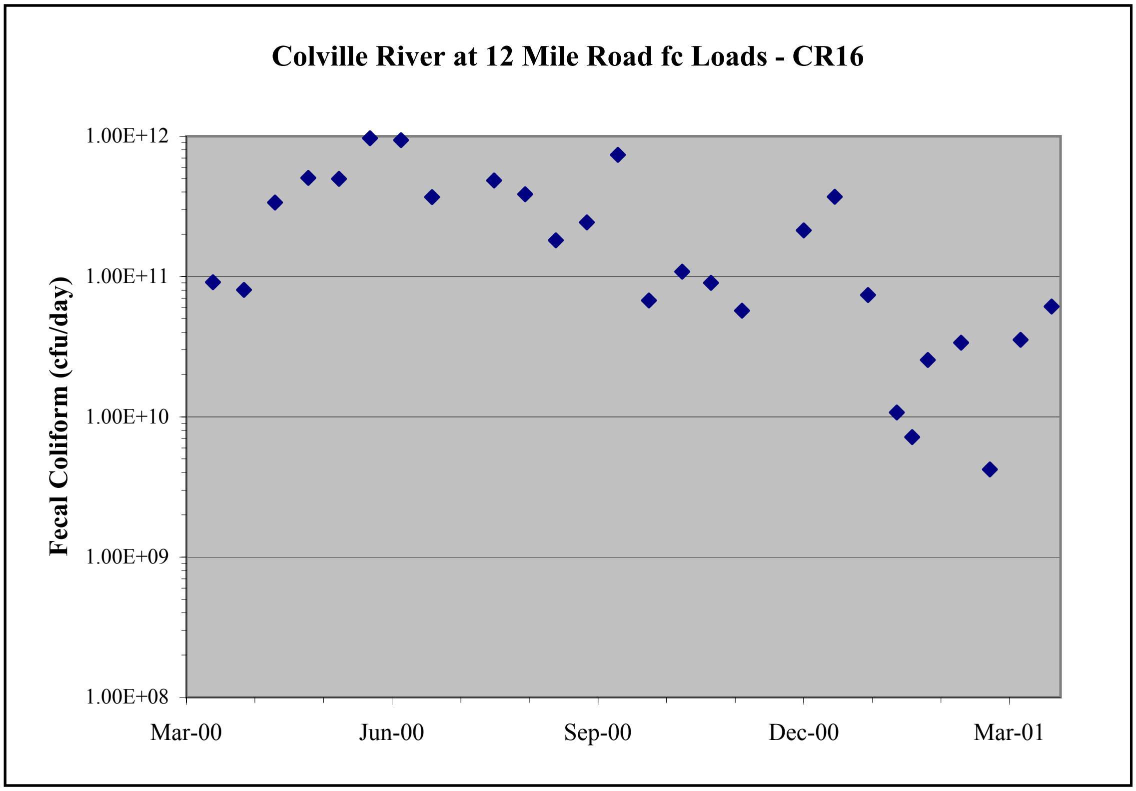


Figure A17. Sample day bacteria density and loads for the STRN15 site.



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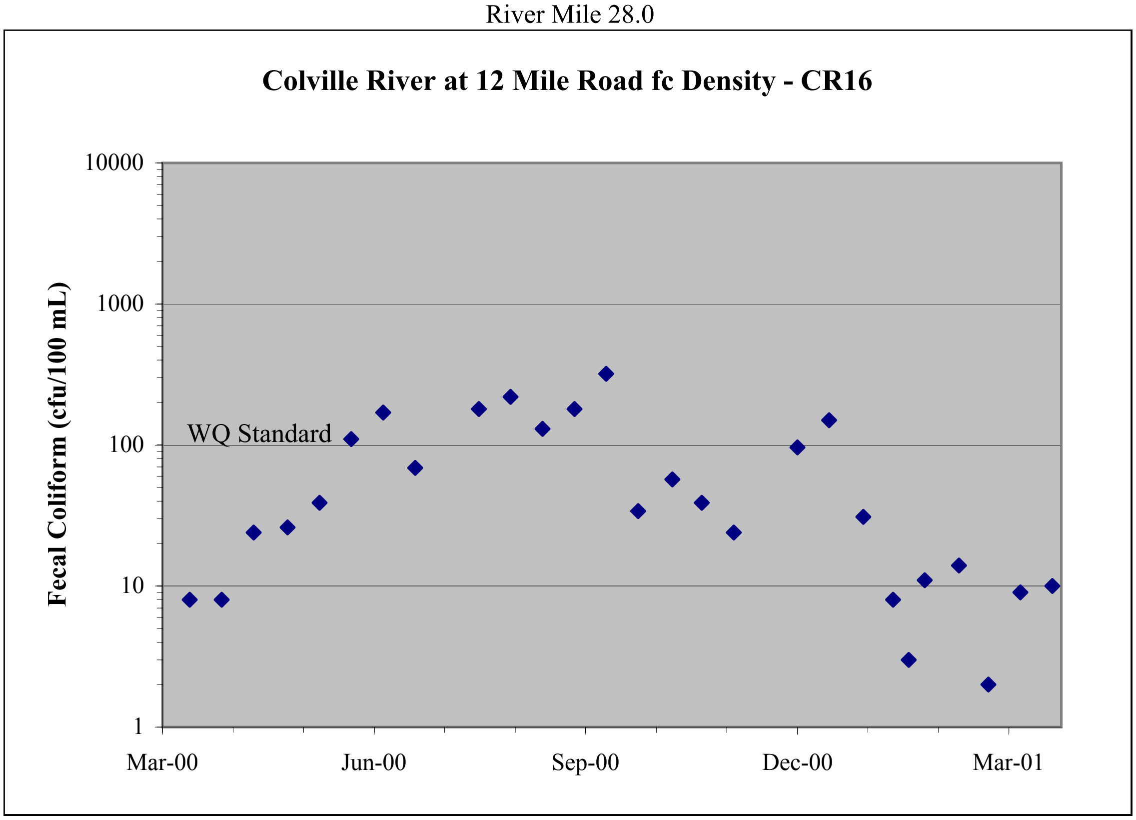
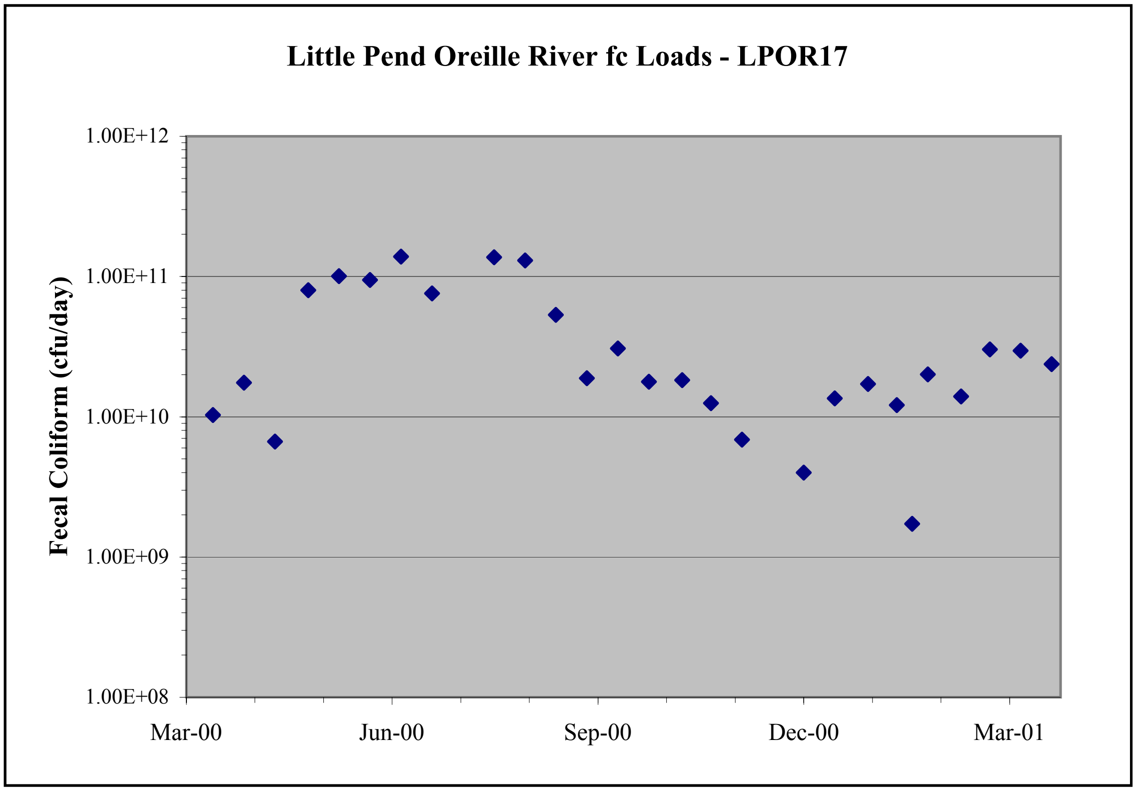


Figure A18. Sample day bacteria density and loads for the CR16 site.



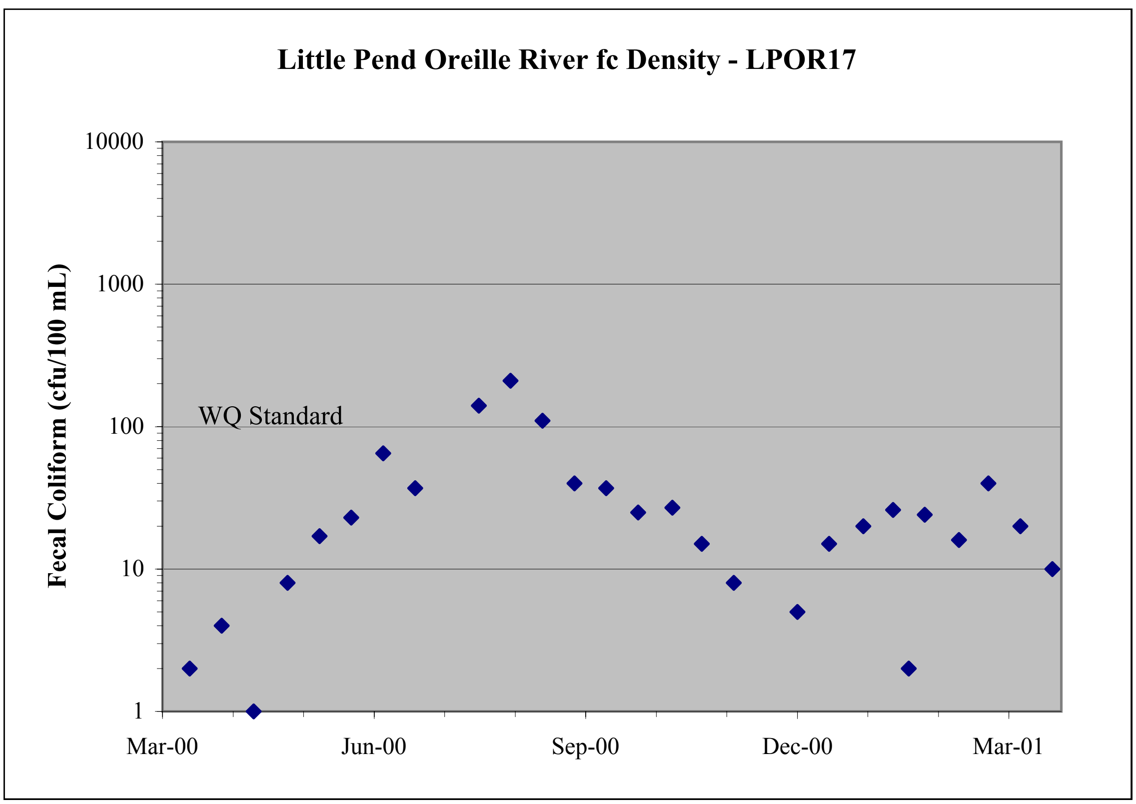
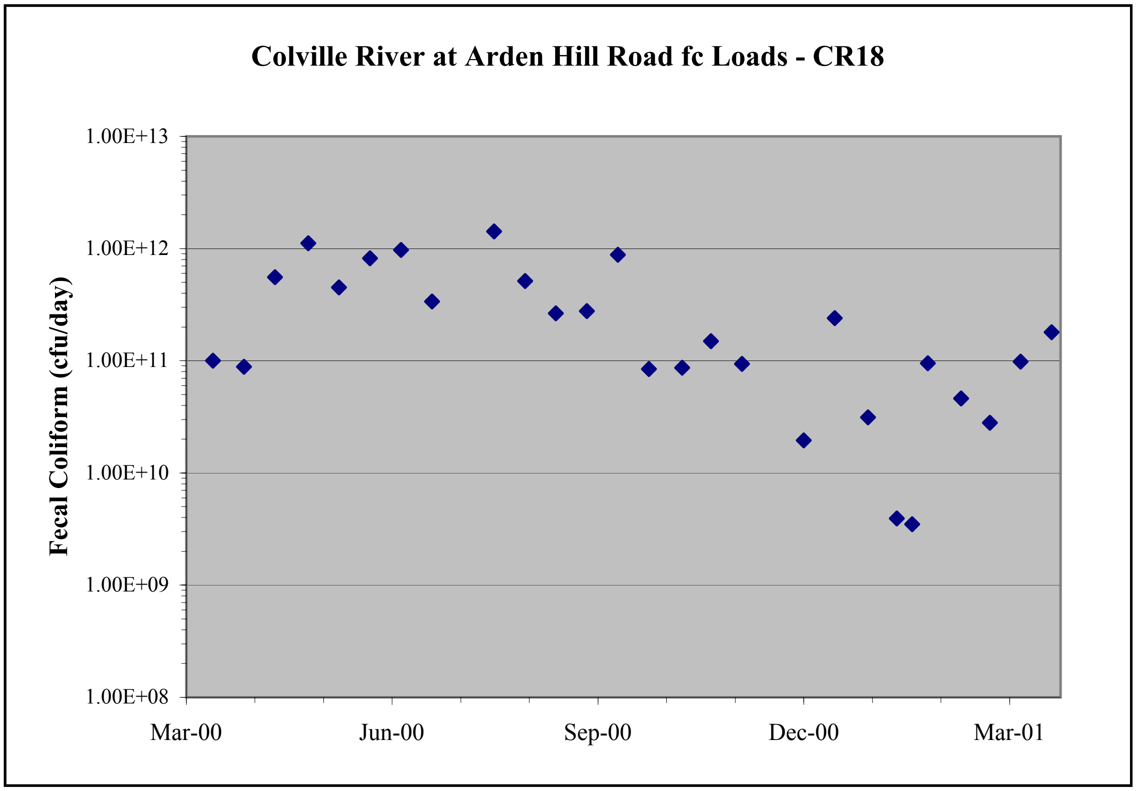


Figure A19. Sample day bacteria density and loads for the LPOR17 site.



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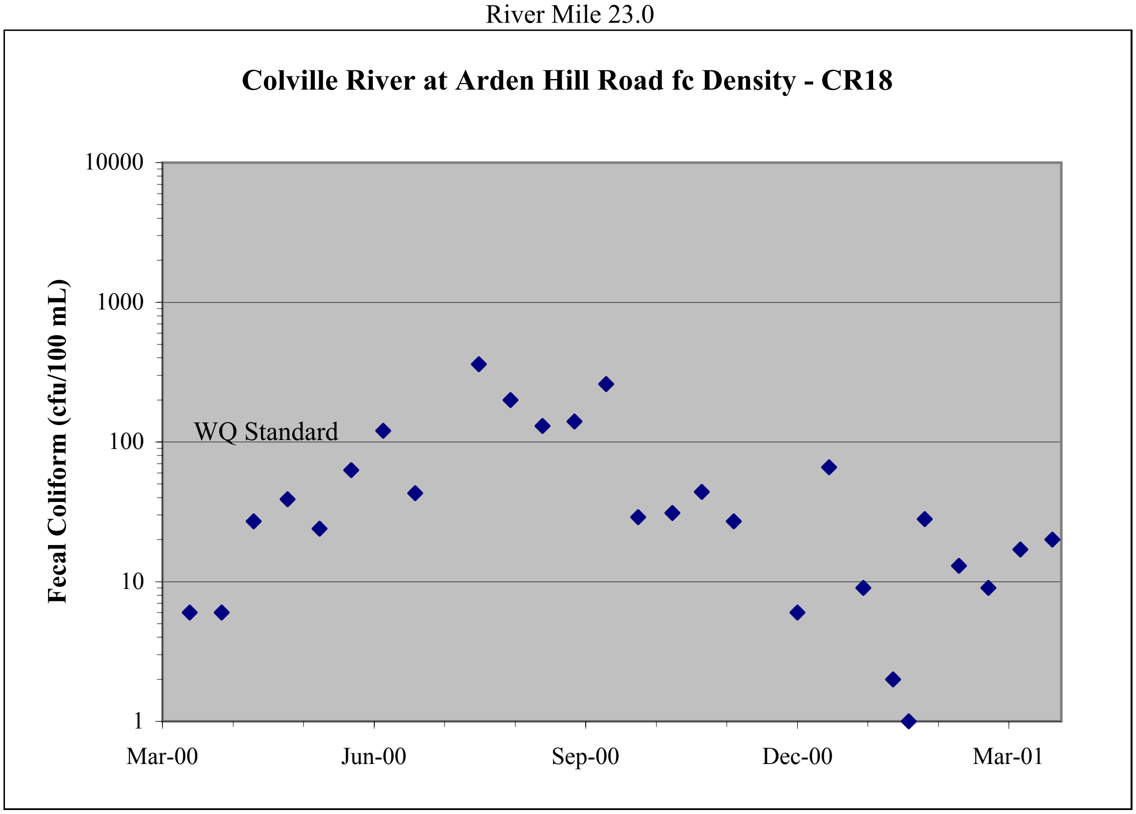
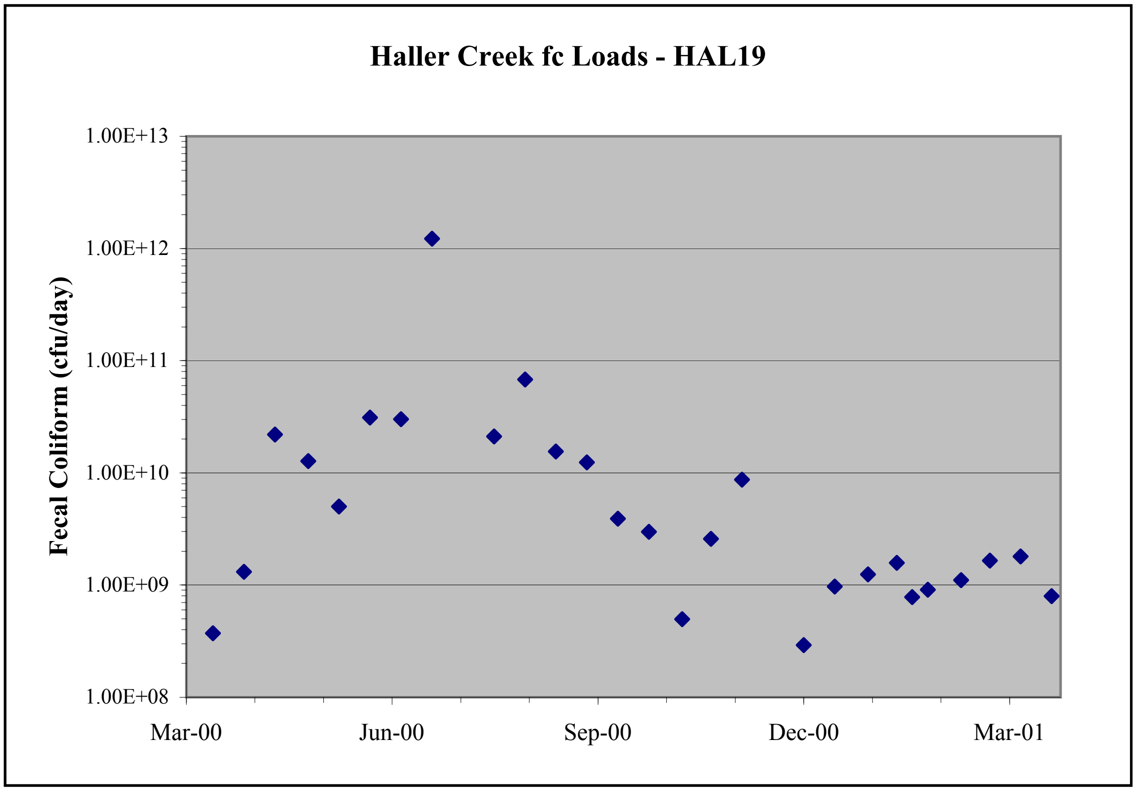


Figure A20. Sample day bacteria density and loads for the CR18 site.



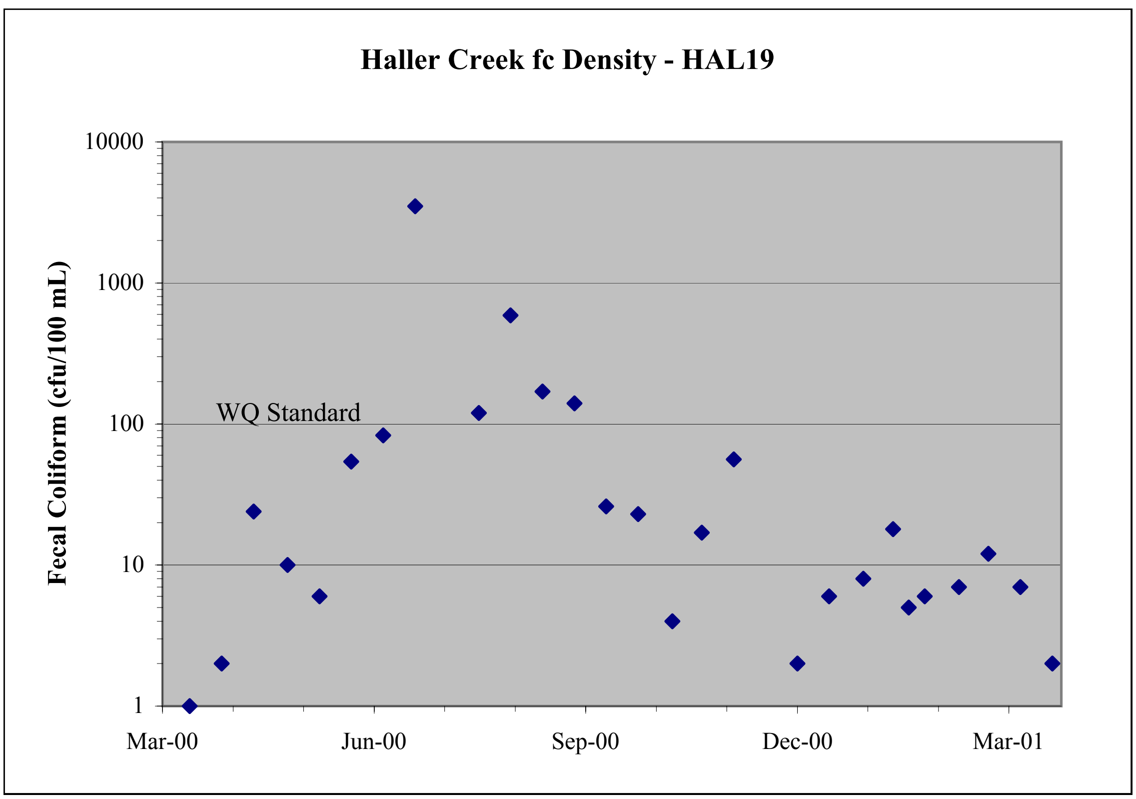
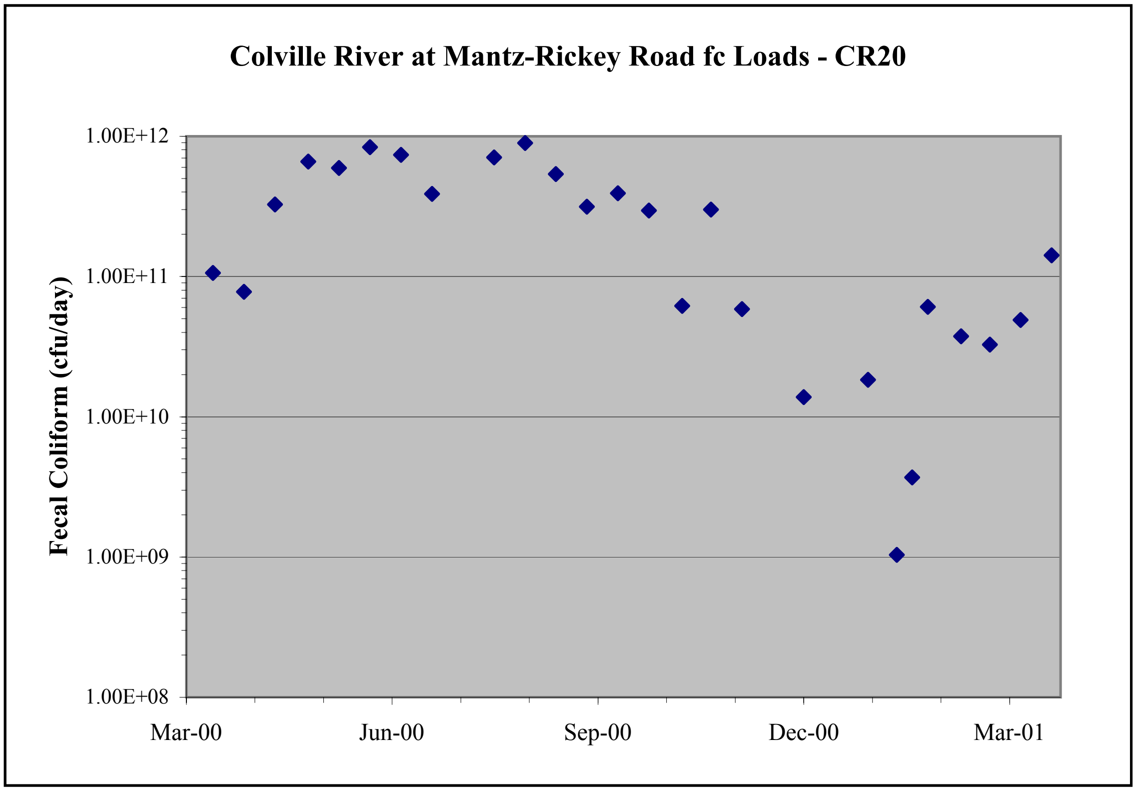


Figure A21. Sample day bacteria density and loads for the HAL19 site.



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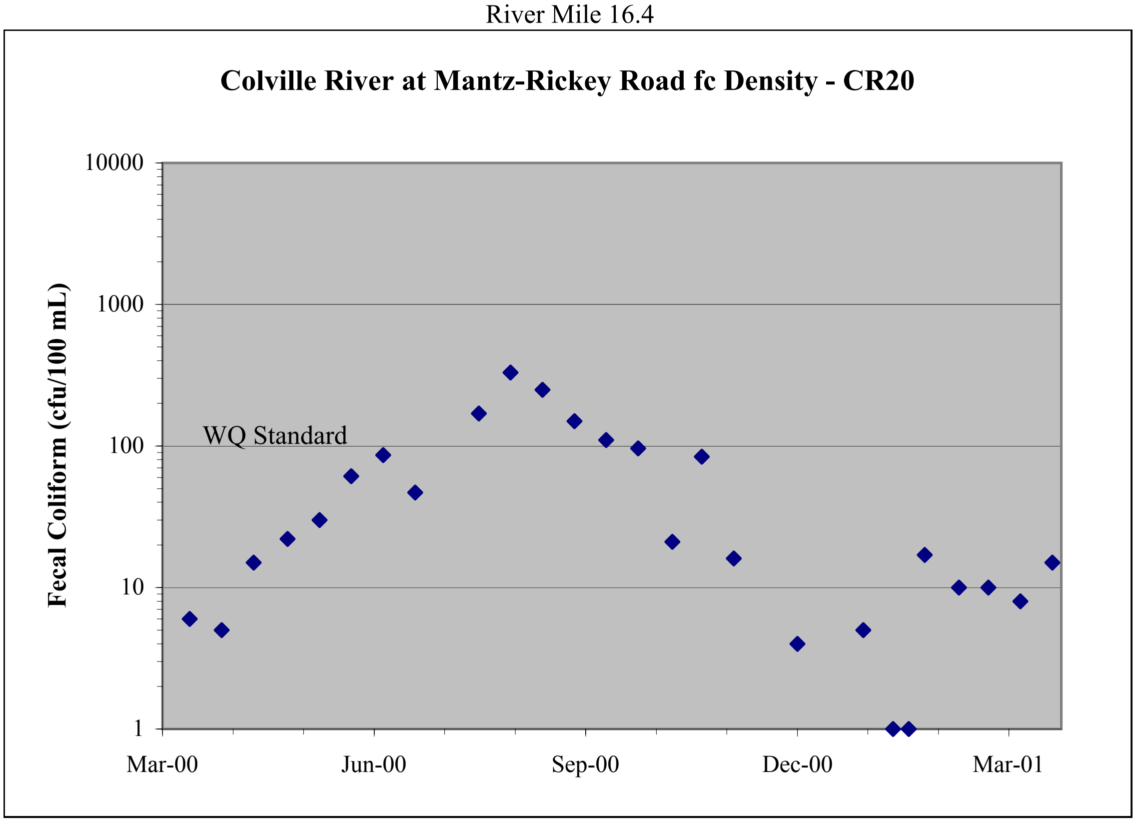
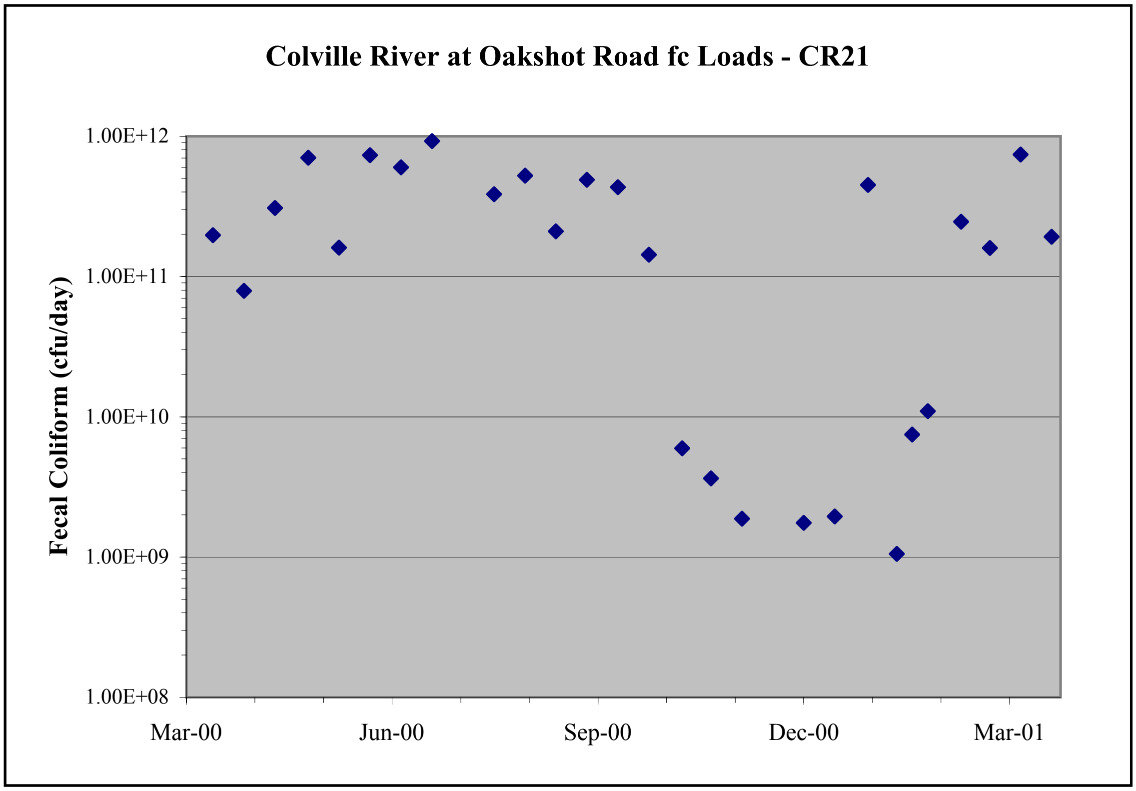


Figure A22. Sample day bacteria density and loads for the CR20 site.



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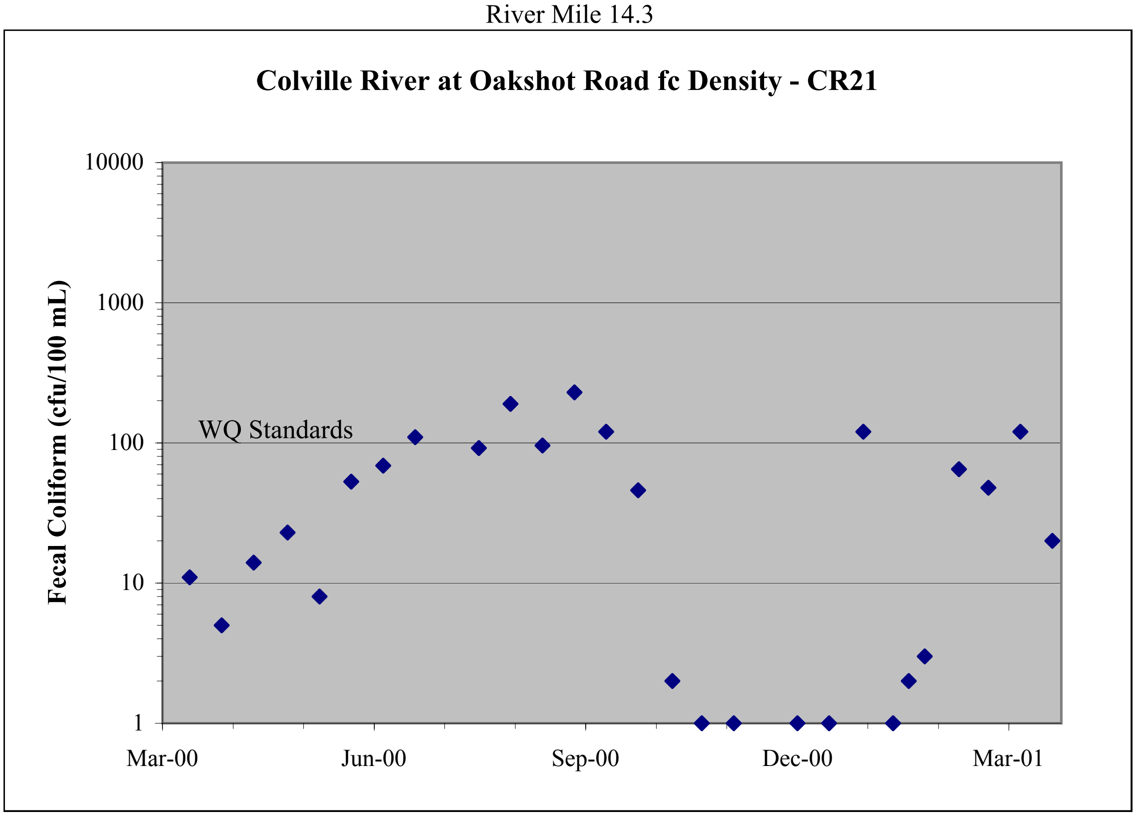
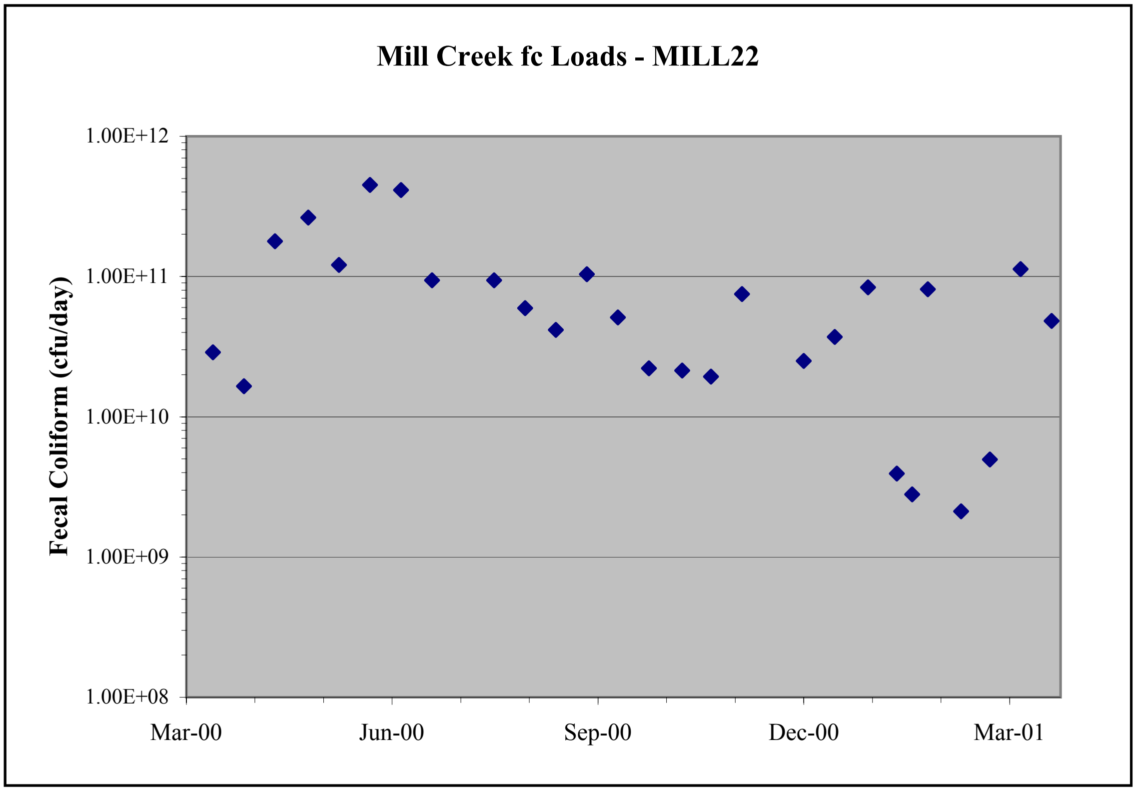


Figure A23. Sample day bacteria density and loads for the CR21 site.



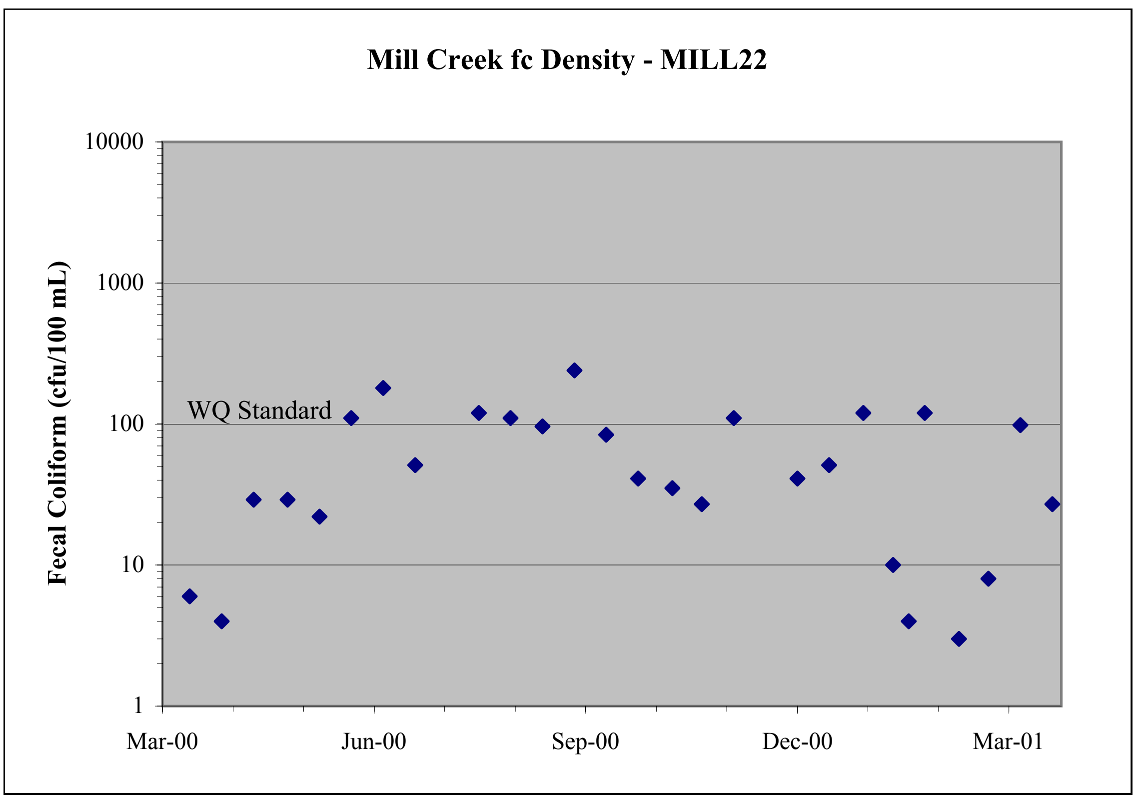
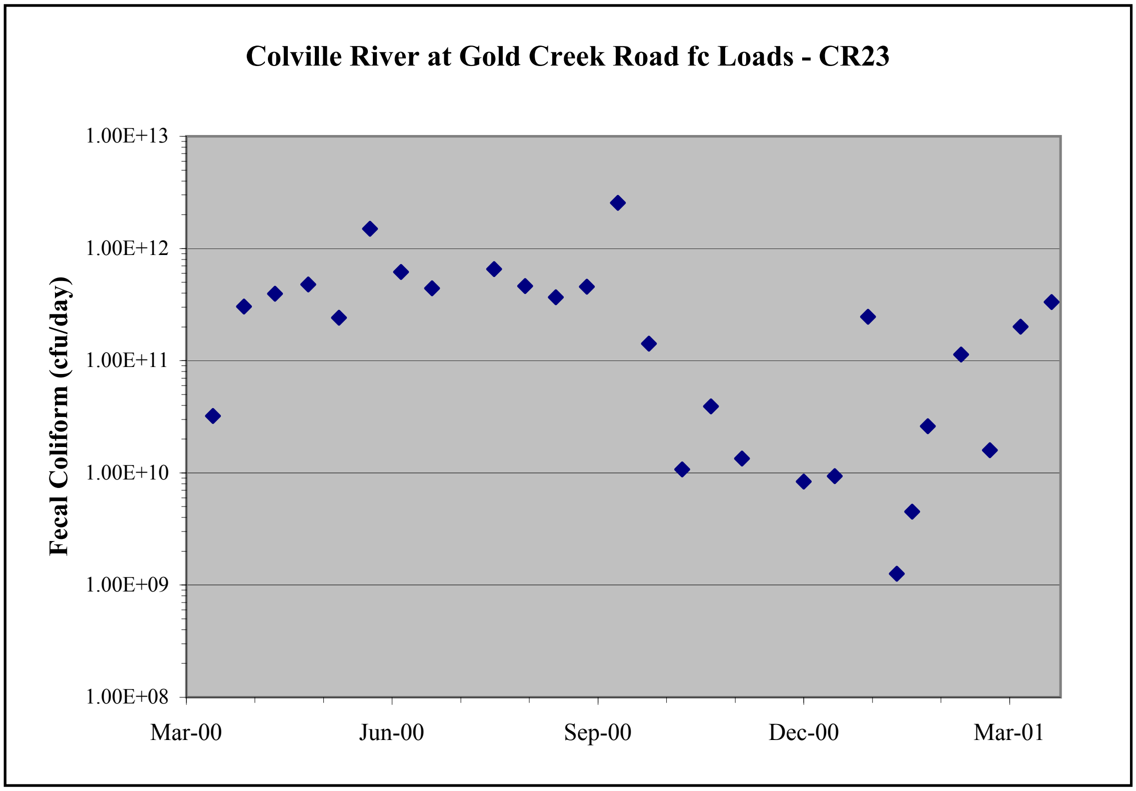


Figure A24. Sample day bacteria density and loads for the MILL22 site.



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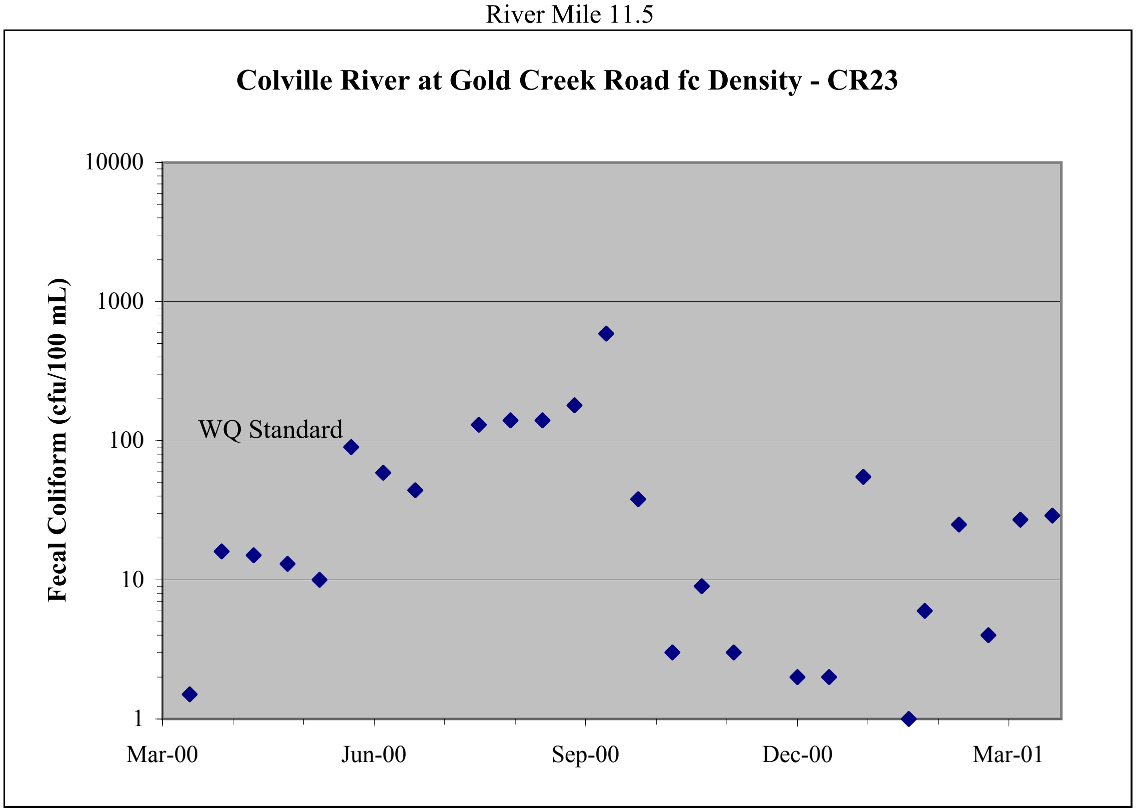
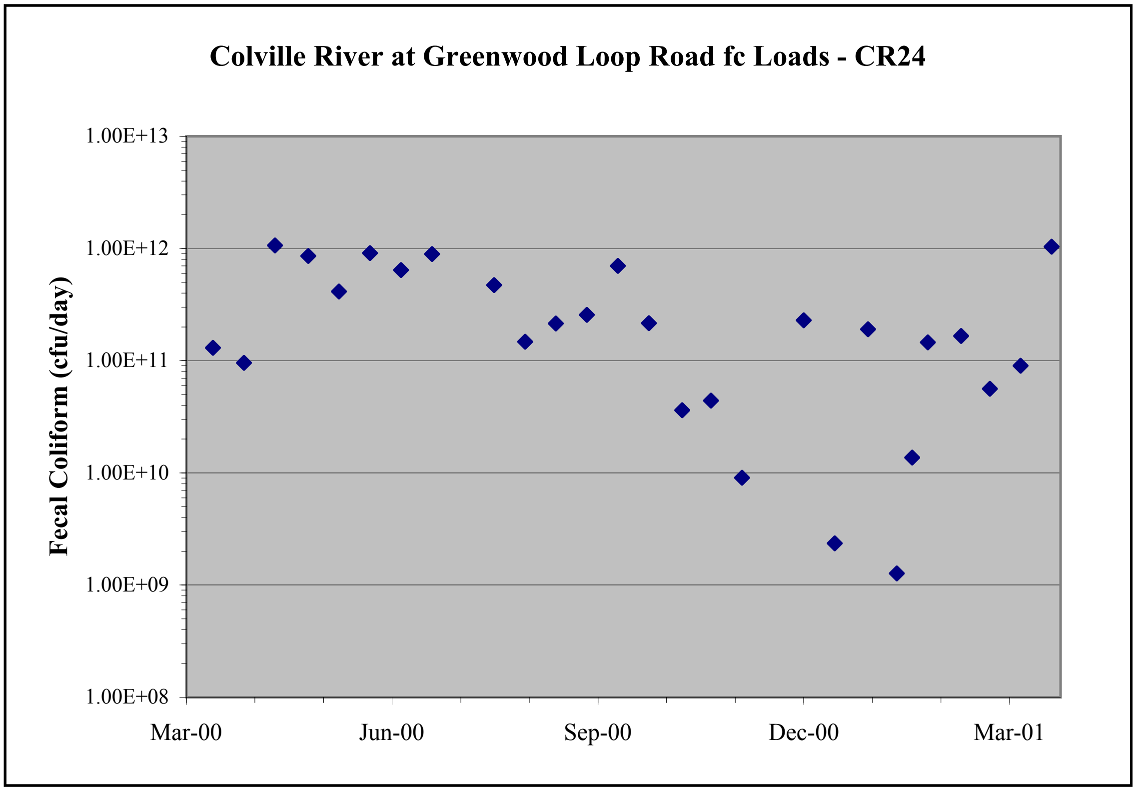


Figure A25. Sample day bacteria density and loads for the CR23 site.



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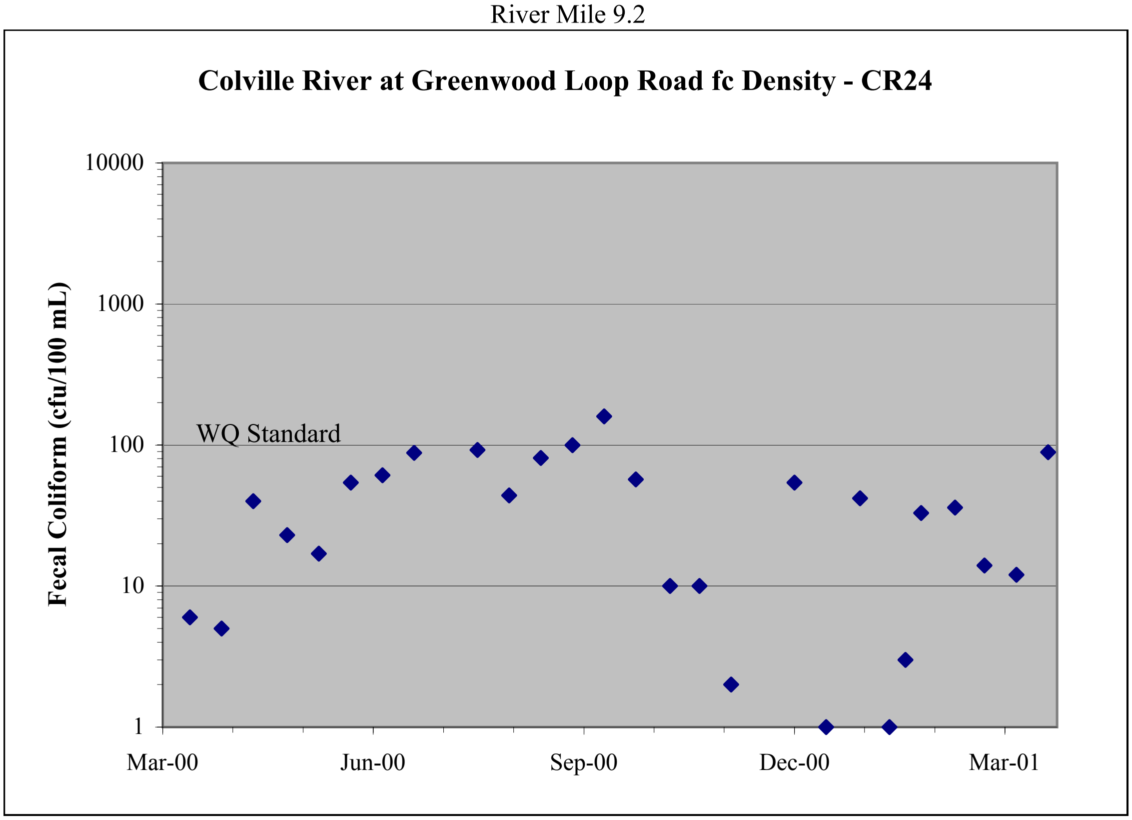
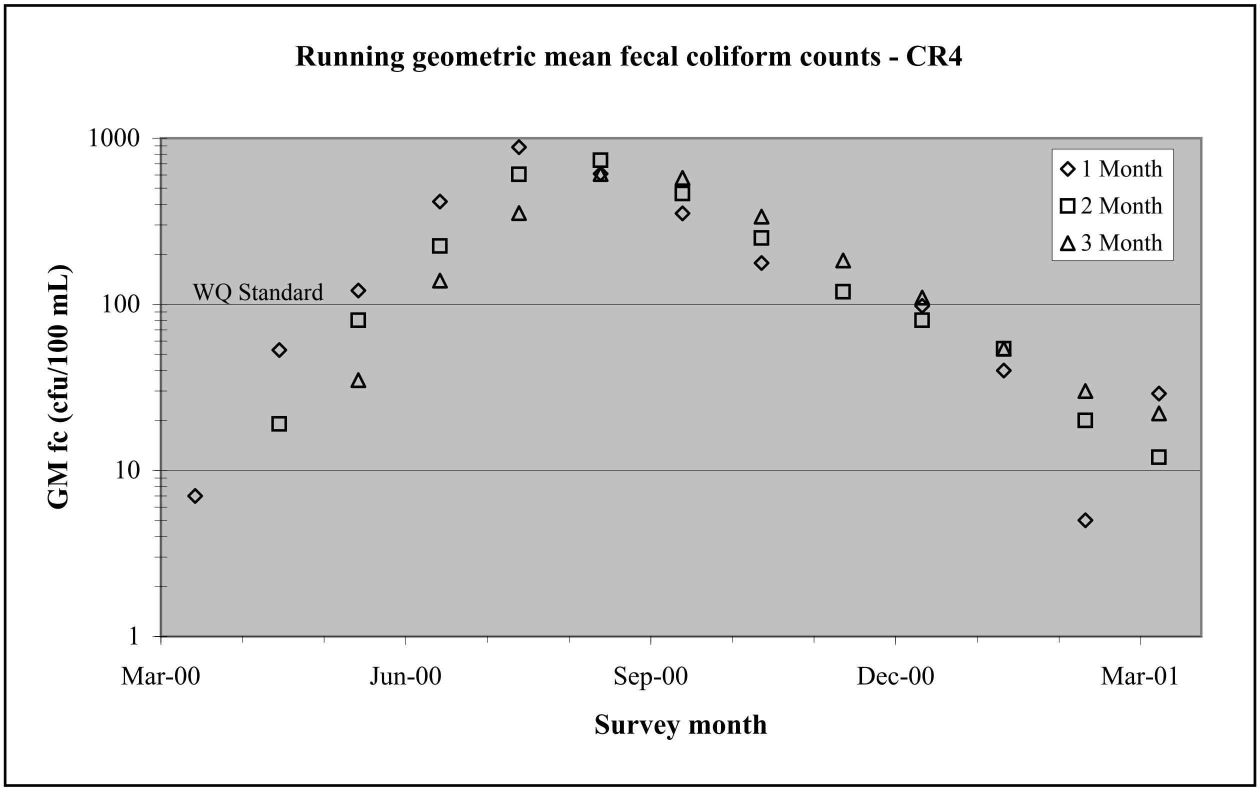


Figure A26. Sample day bacteria density and loads for the CR24 site.



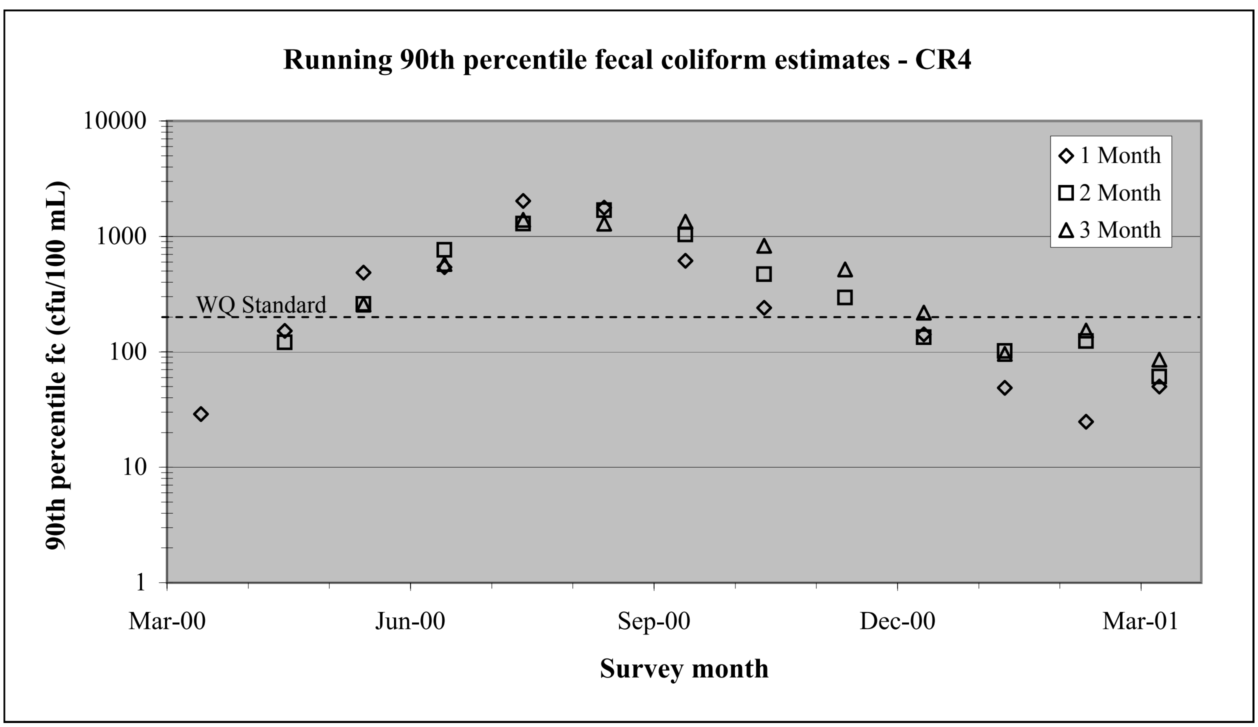
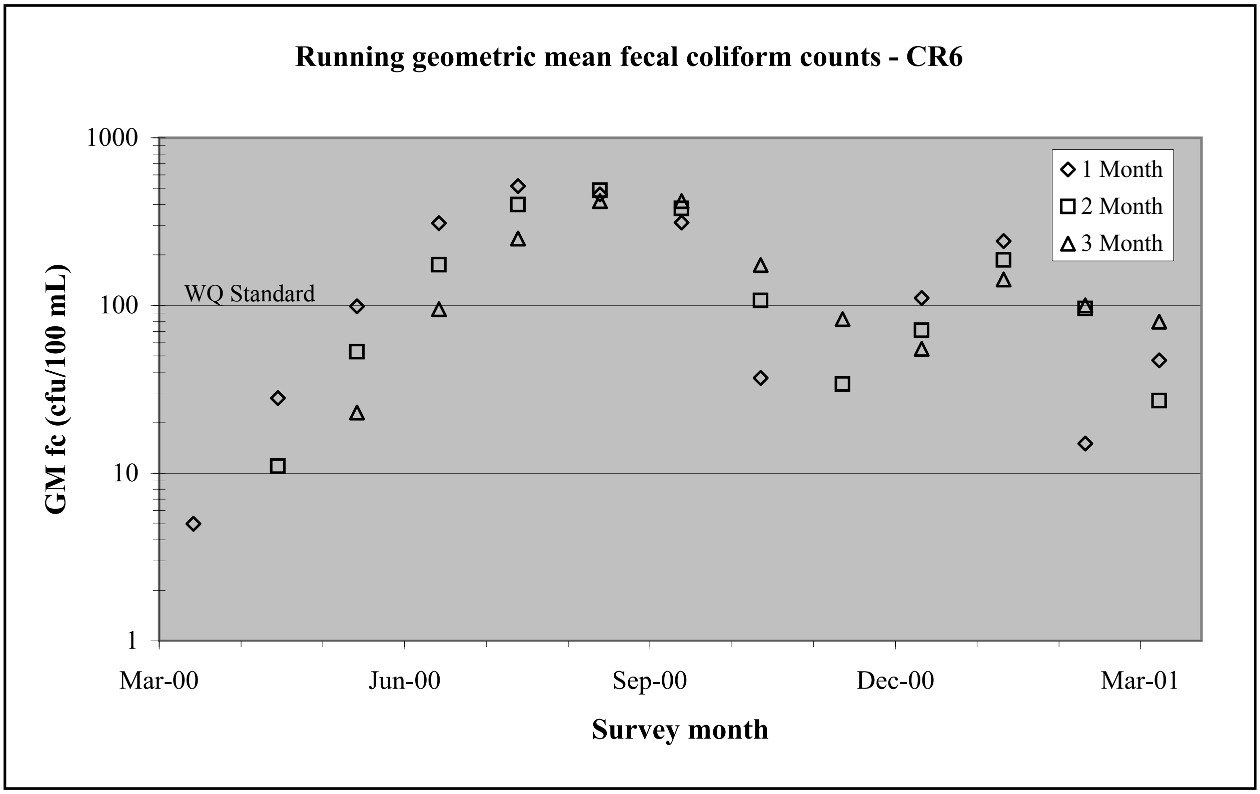


Figure A27. Running geometric mean and 90th percentiles for site CR4.



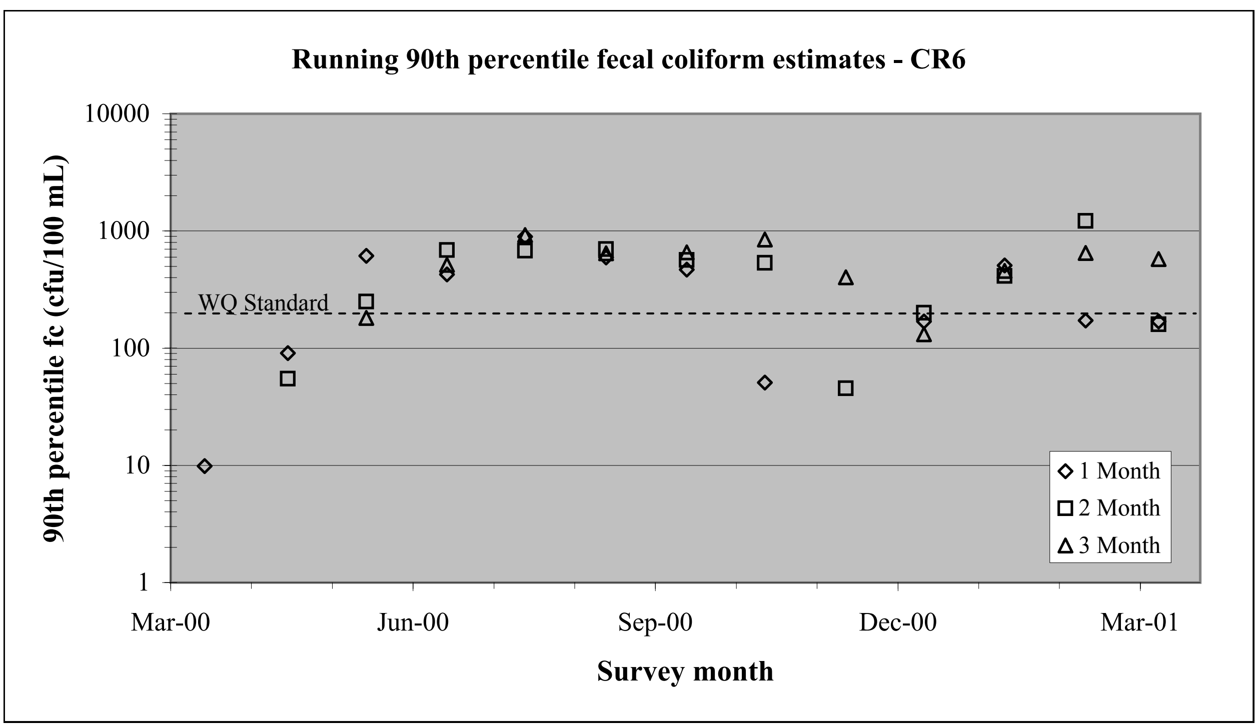
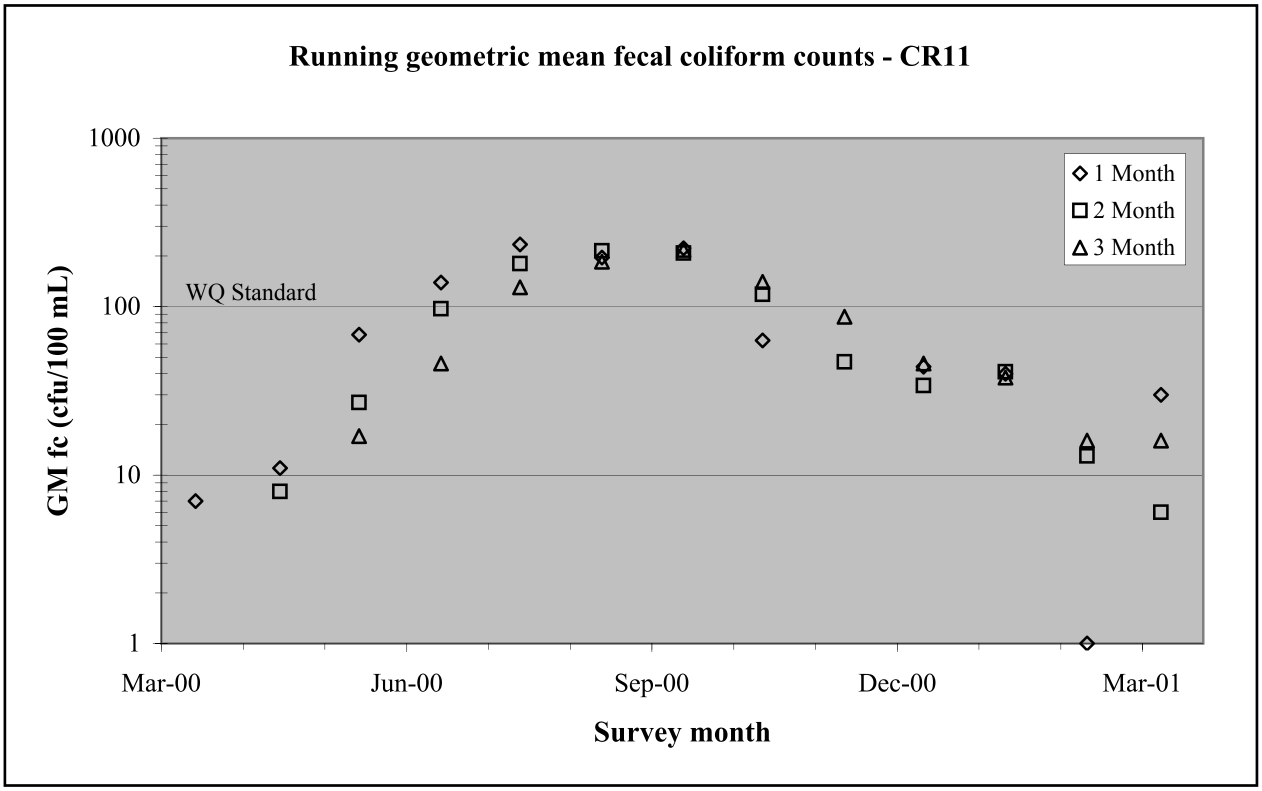


Figure A28. Running geometric mean and 90th percentiles of site CR6.



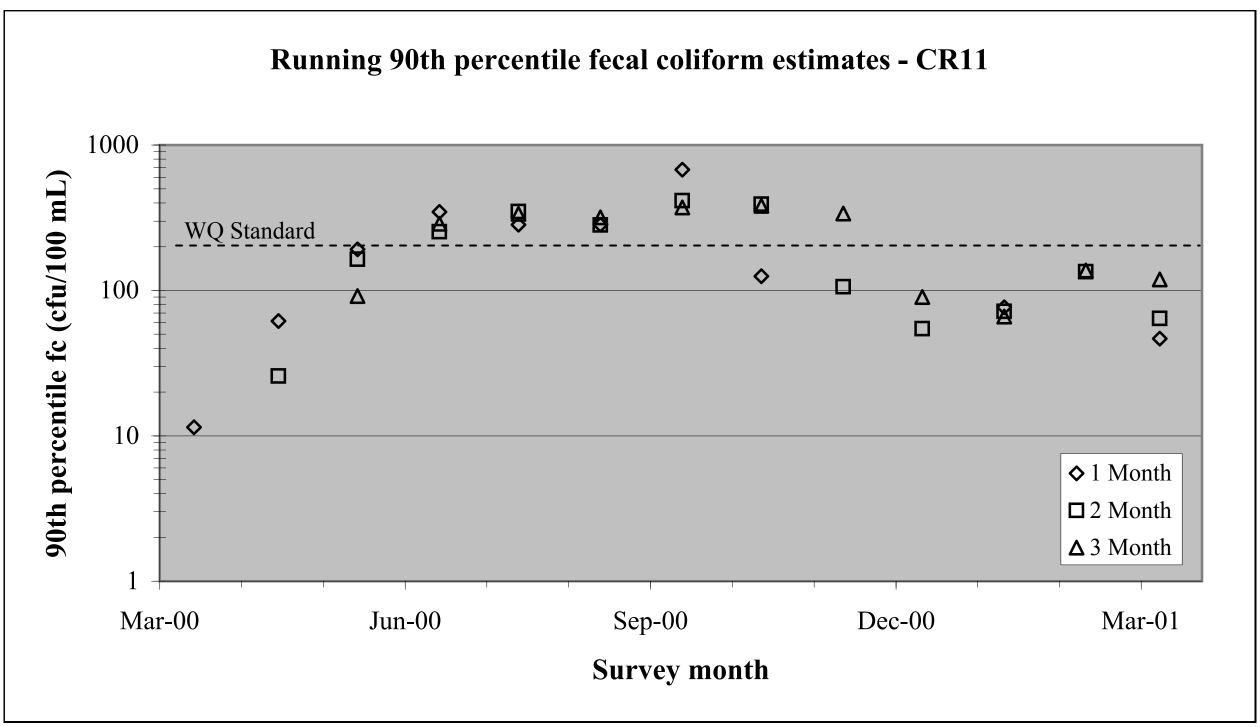
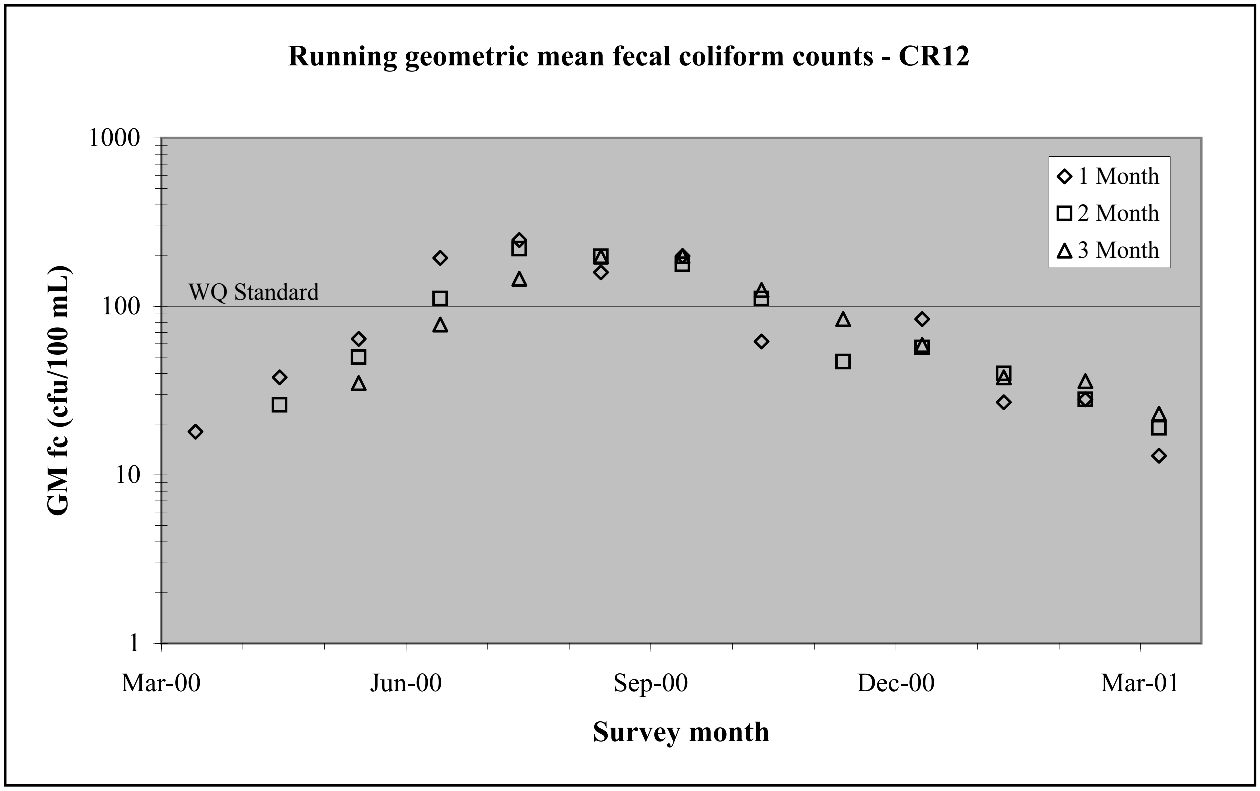


Figure A29. Running geometric mean and 90th percentiles for the site CR11.



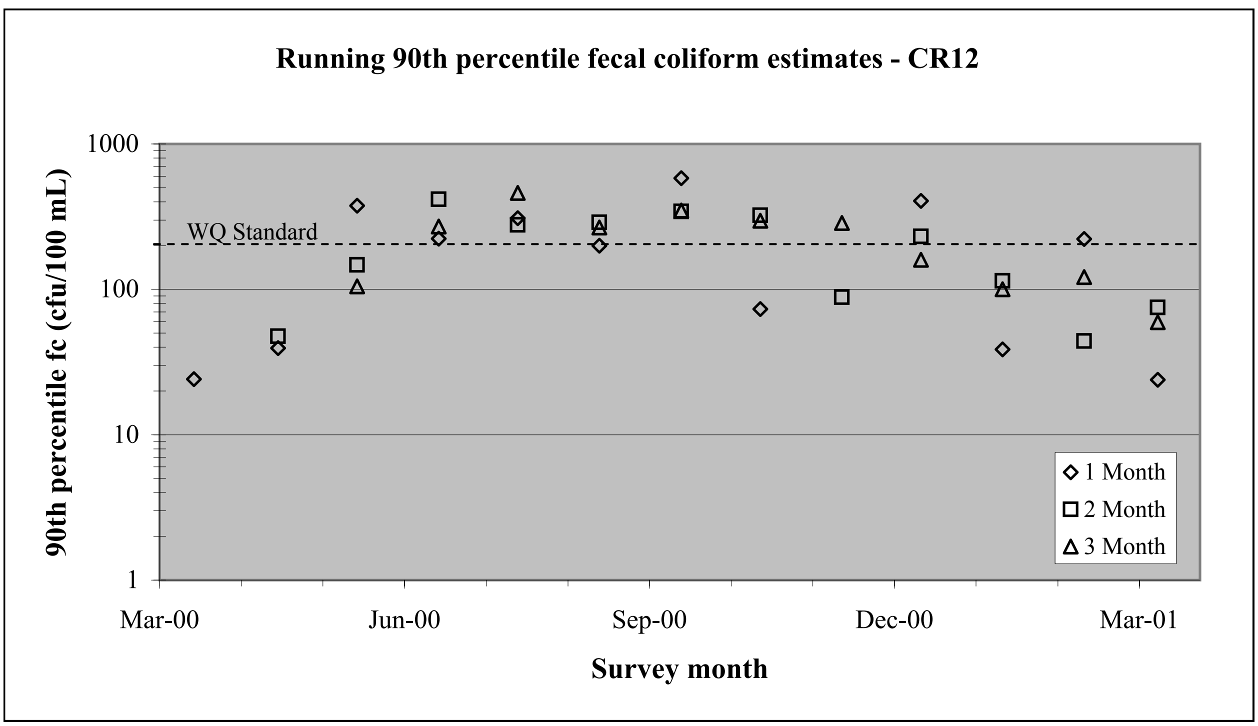
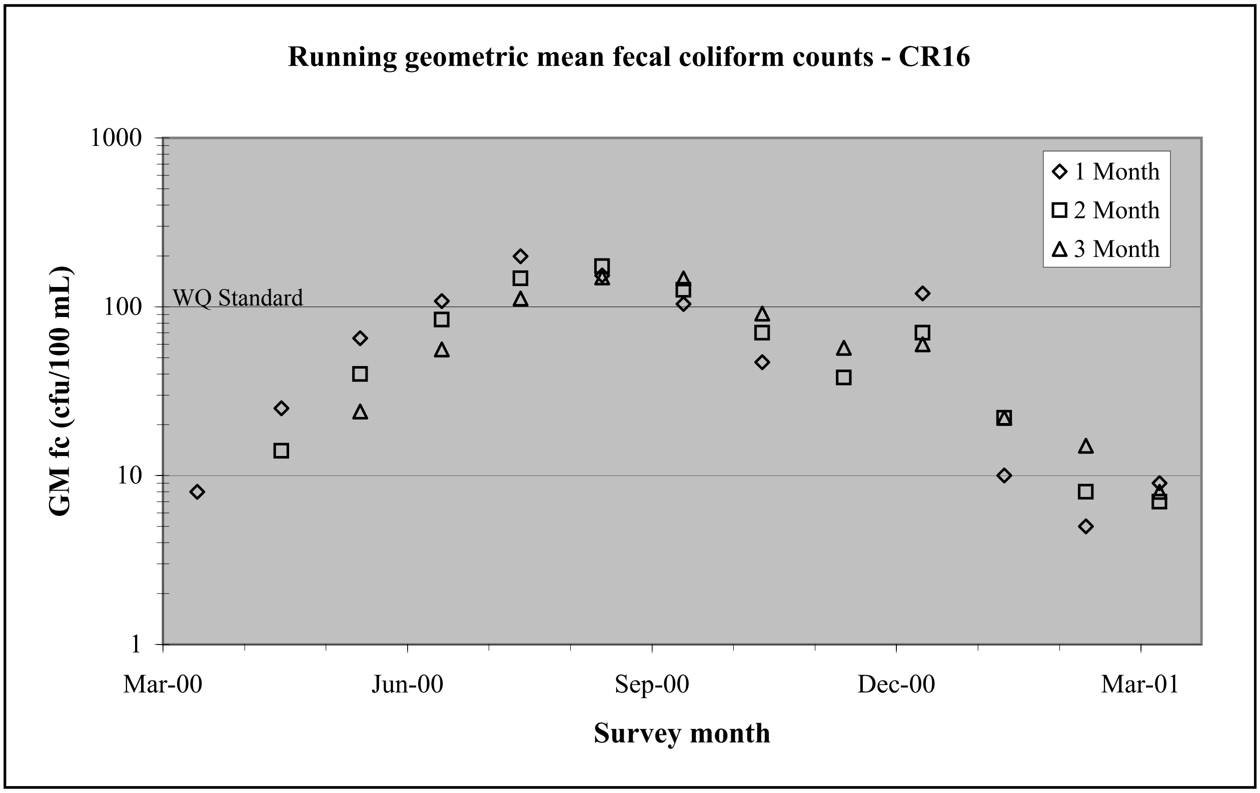


Figure A30. Running geometric mean and 90th percentiles of site CR12.



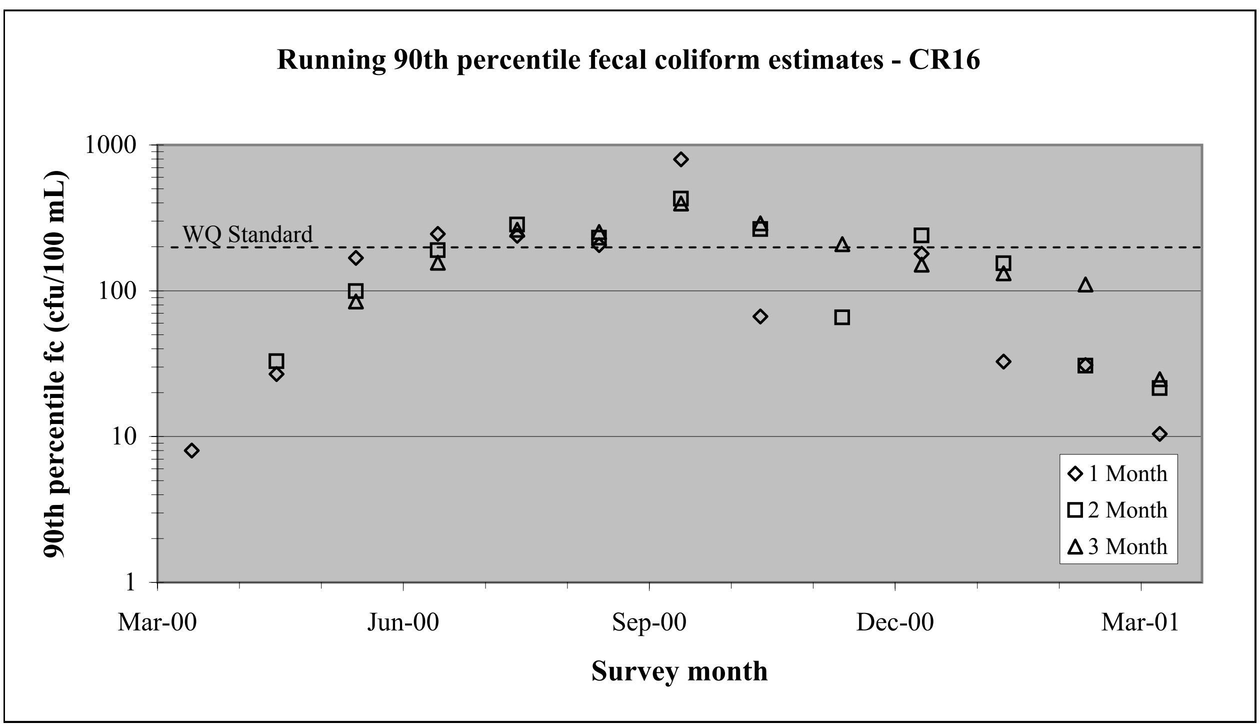
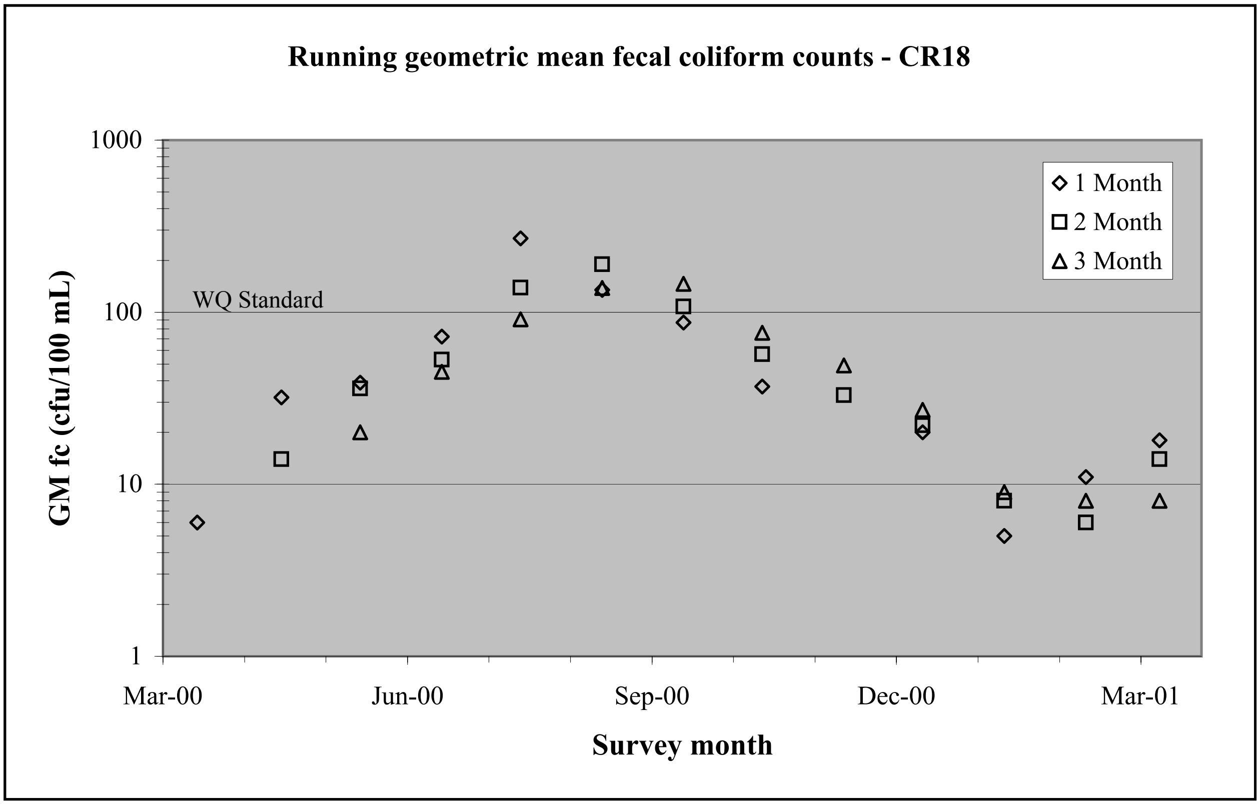


Figure A31. Running geometric mean and 90th percentiles for the site CR16.



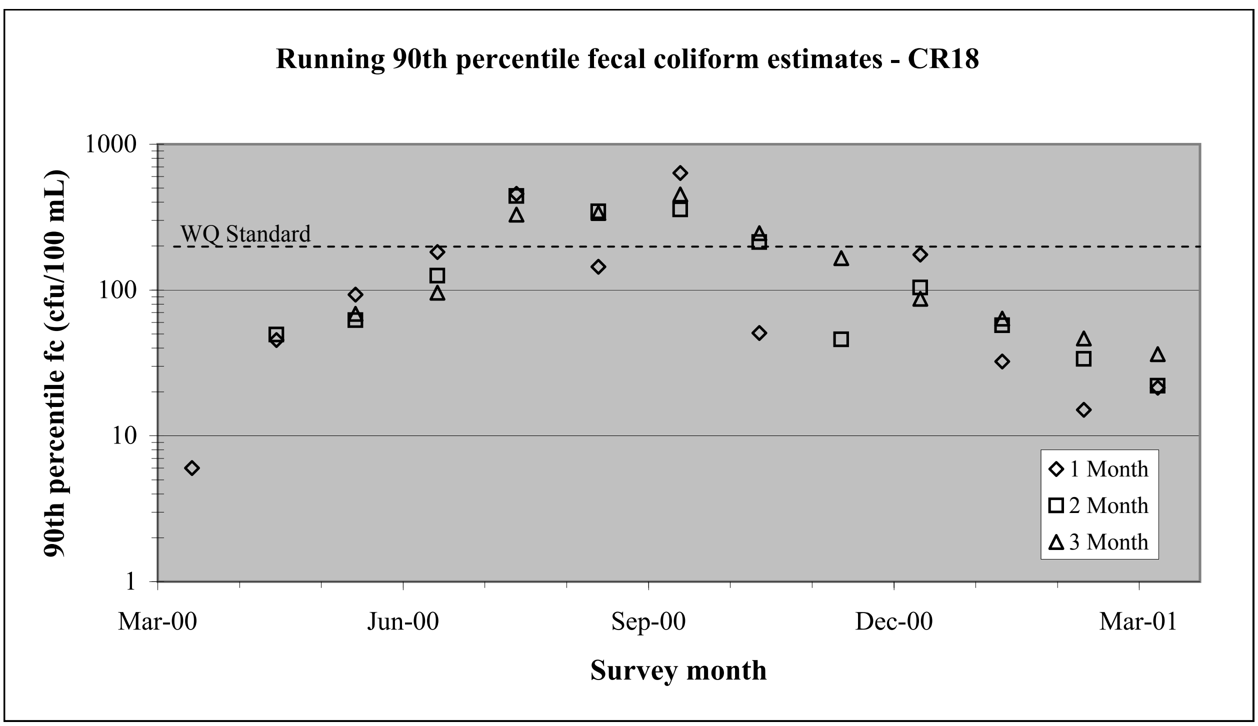
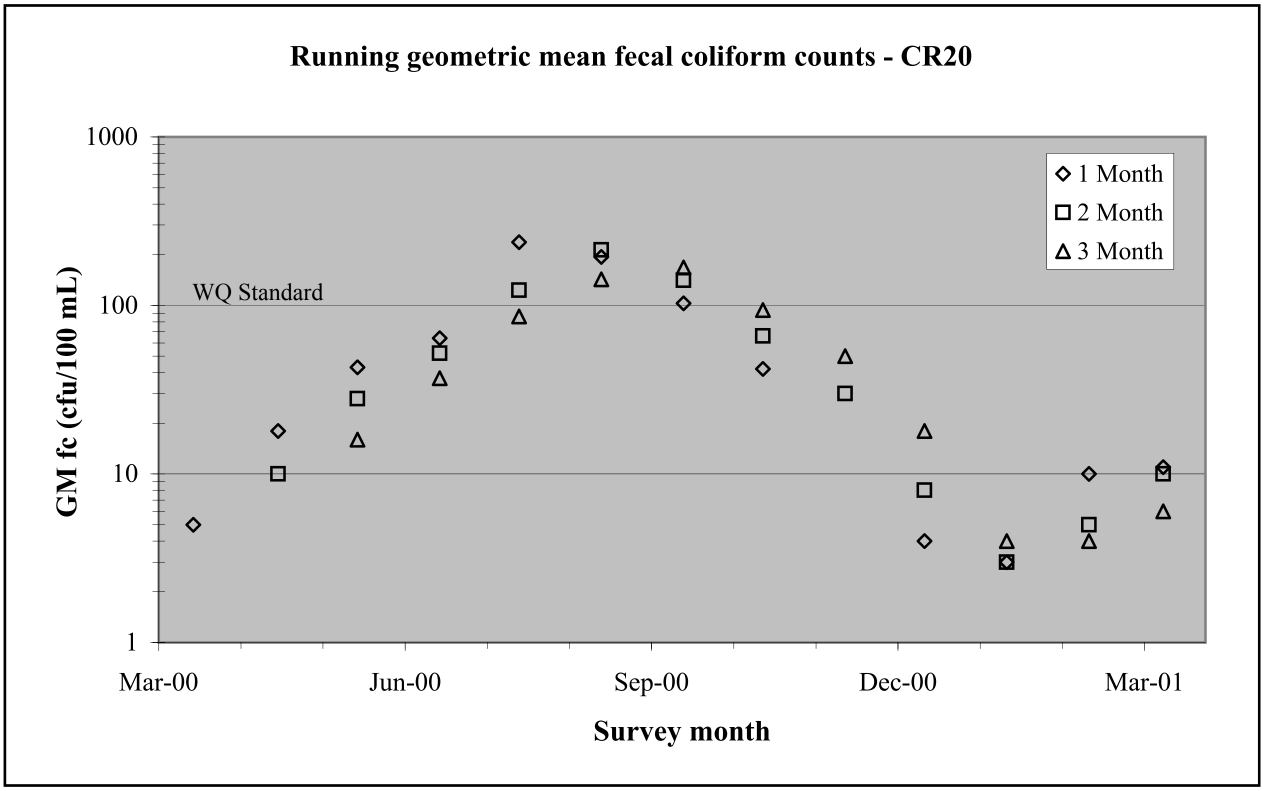


Figure A32. Running geometric mean and 90th percentiles for the site CR18.



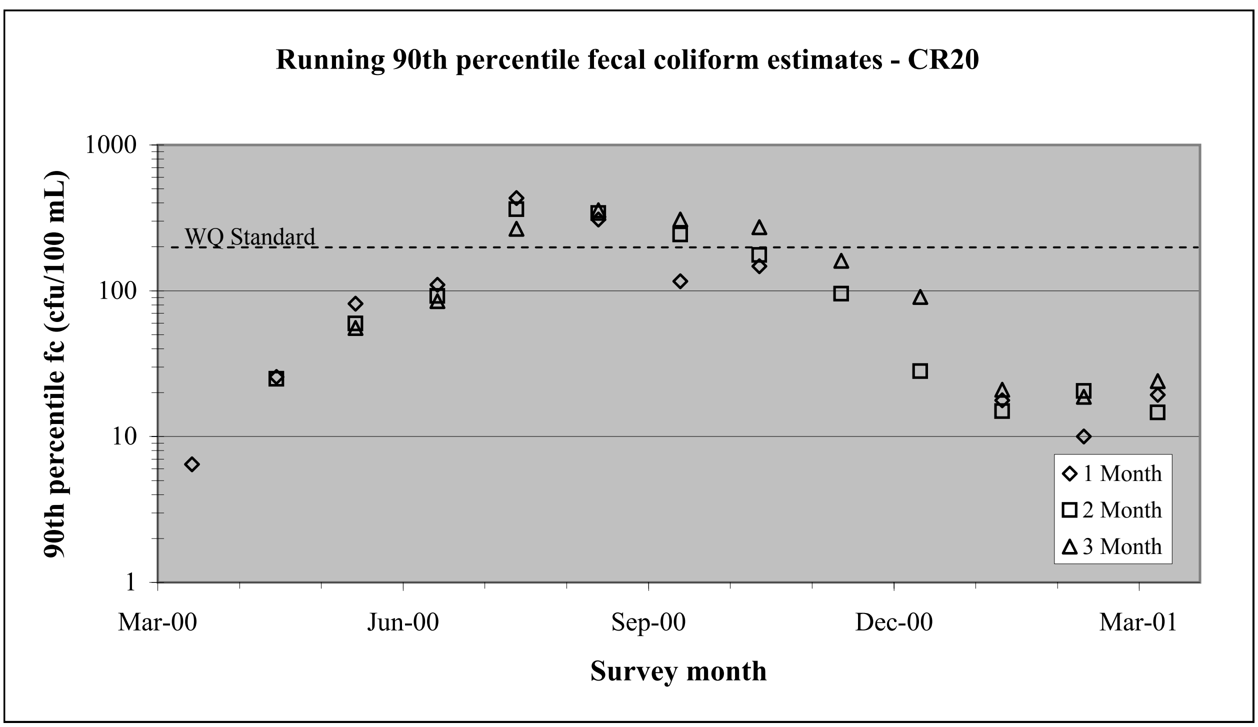
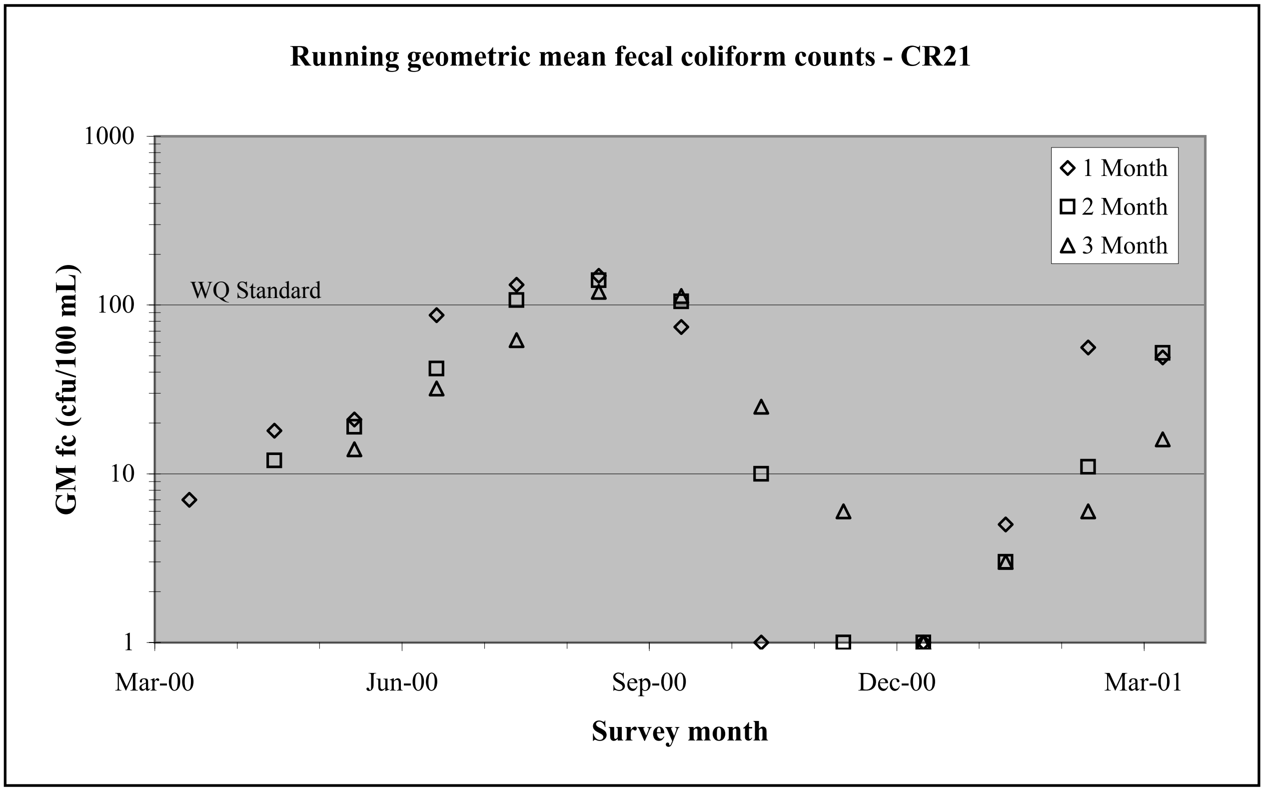


Figure A33. Running geometric mean and 90th percentiles for the site CR20.



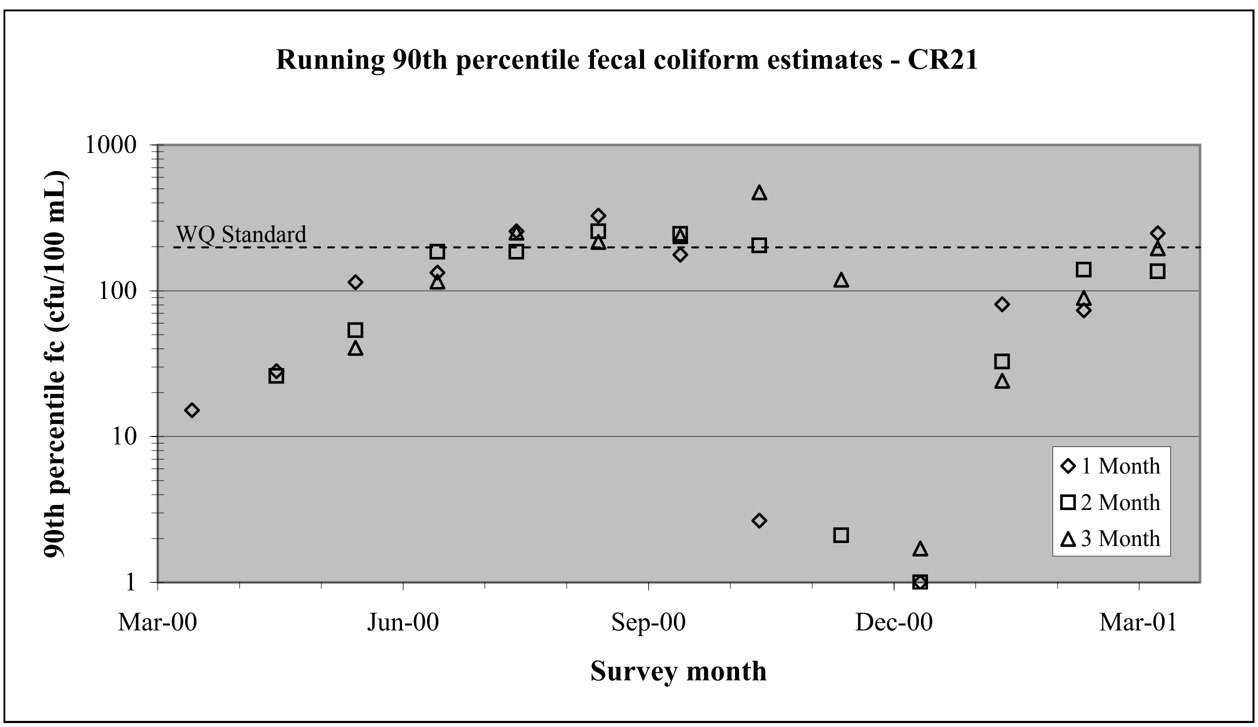
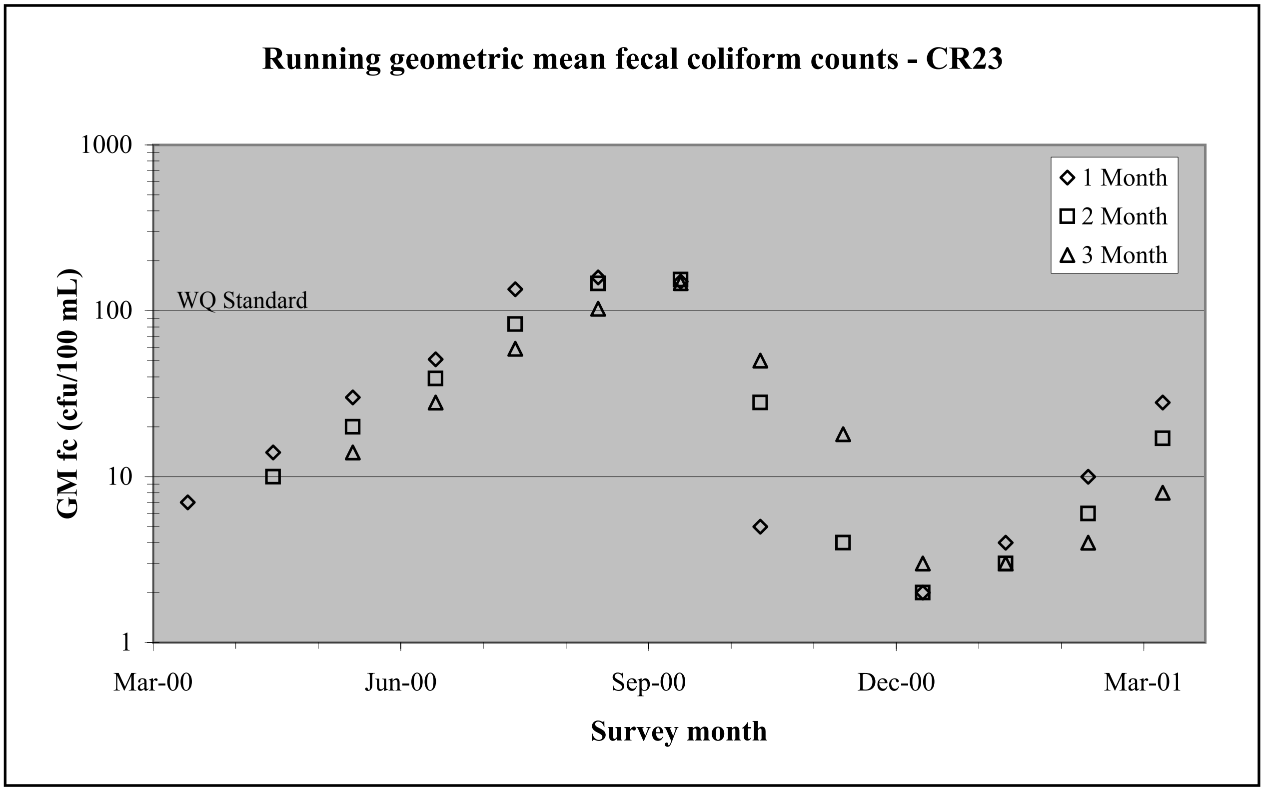


Figure A34. Running geometric mean and 90th percentiles for the CR21 site.



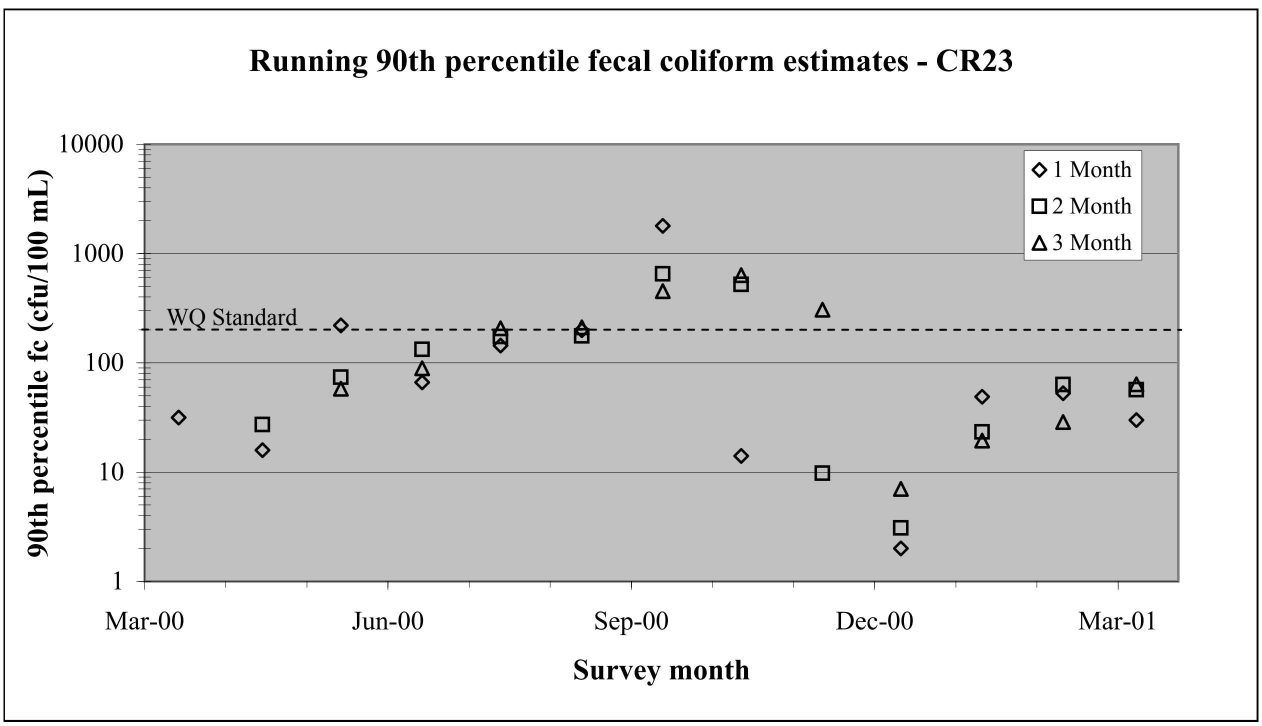
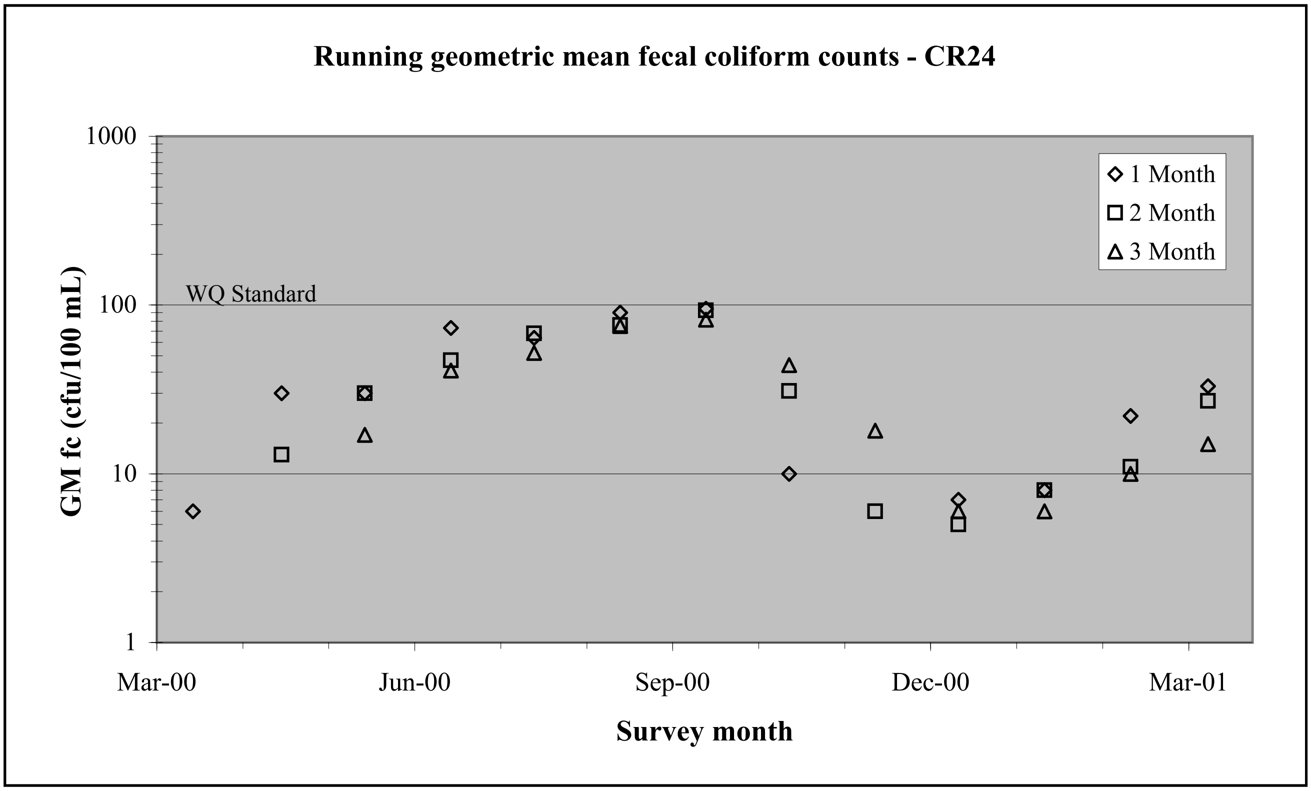


Figure A35. Running geometric means and 90th percentiles for the site CR23.



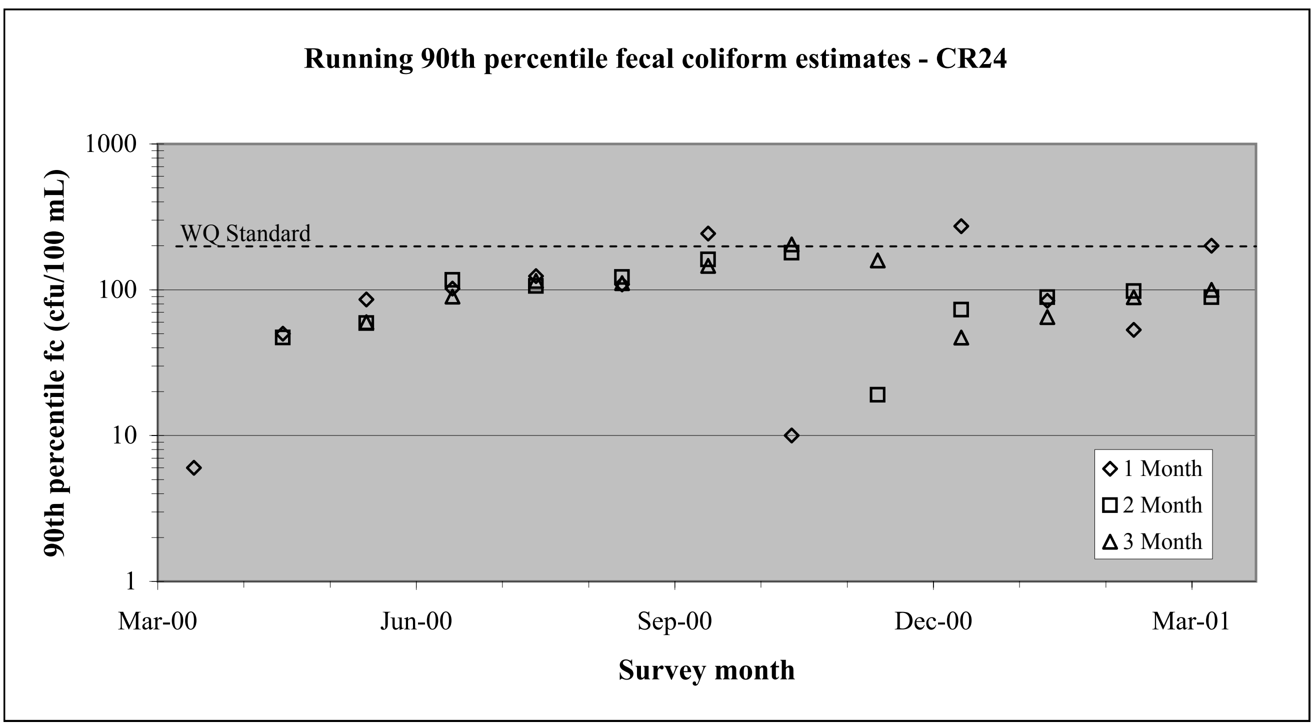
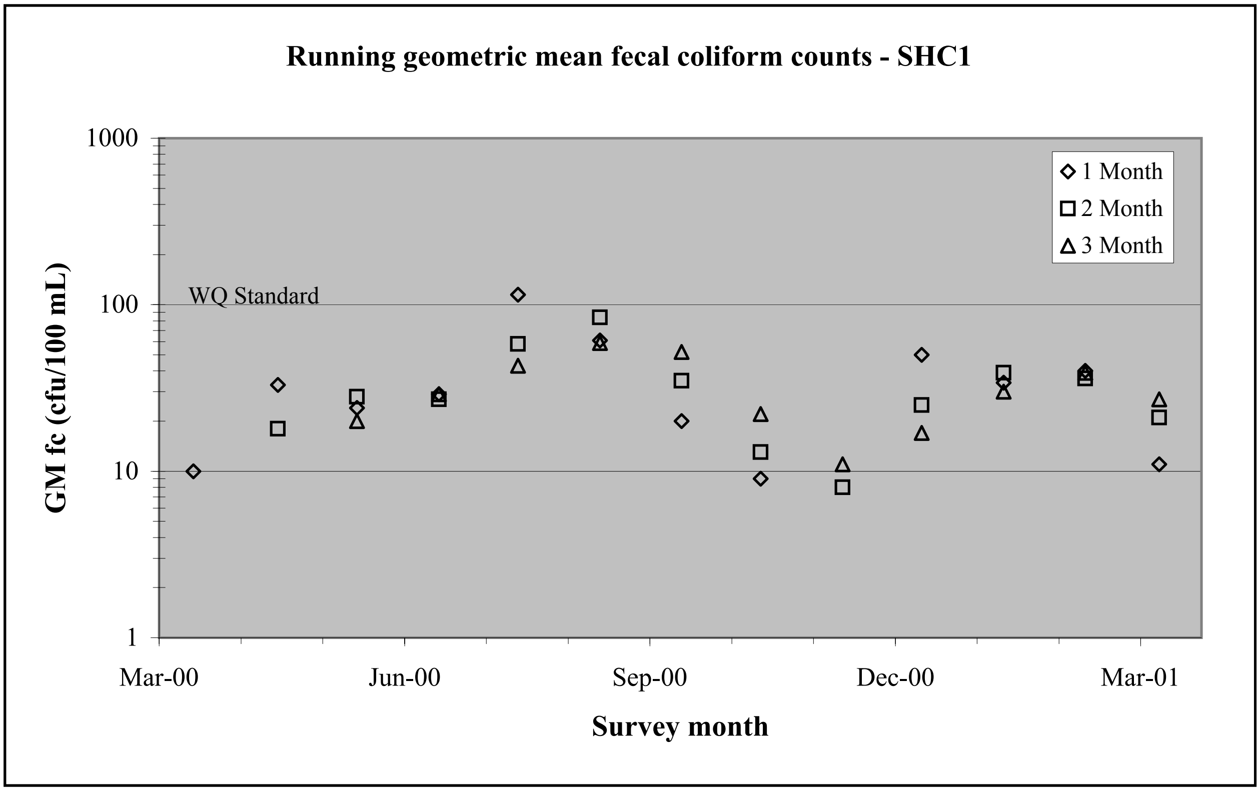


Figure A36. Running geometric mean and 90th percentiles for the site CR24.



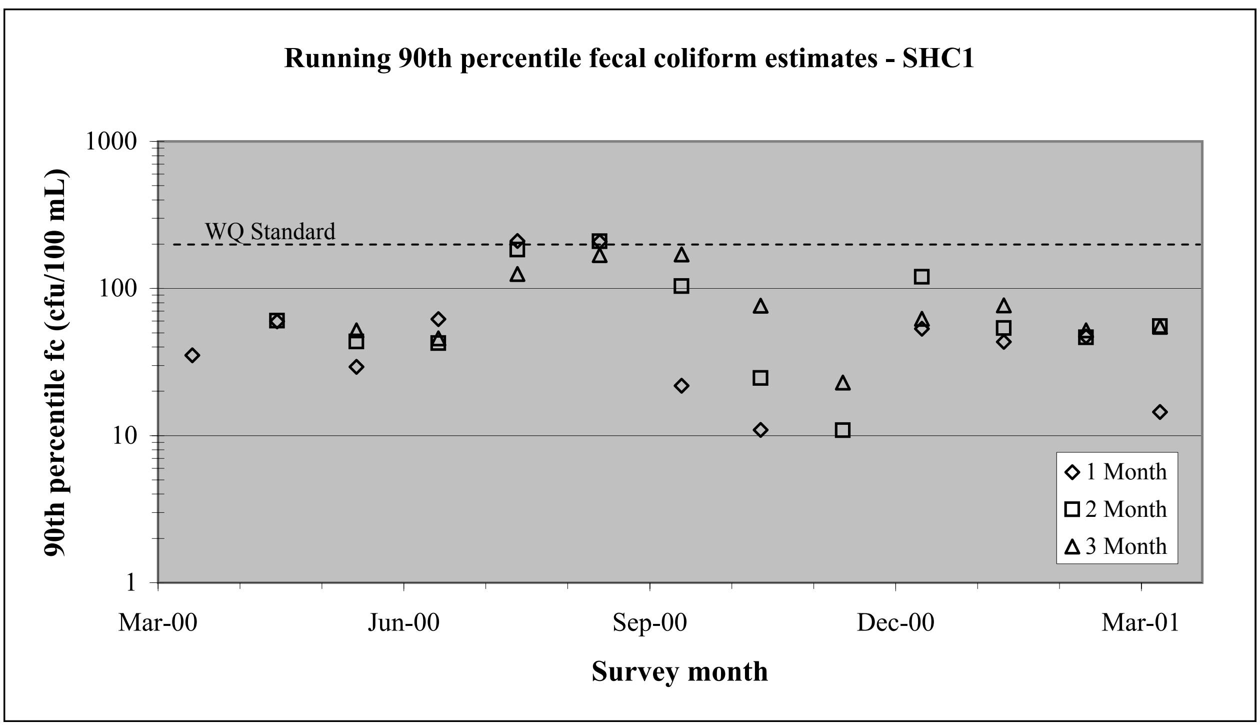
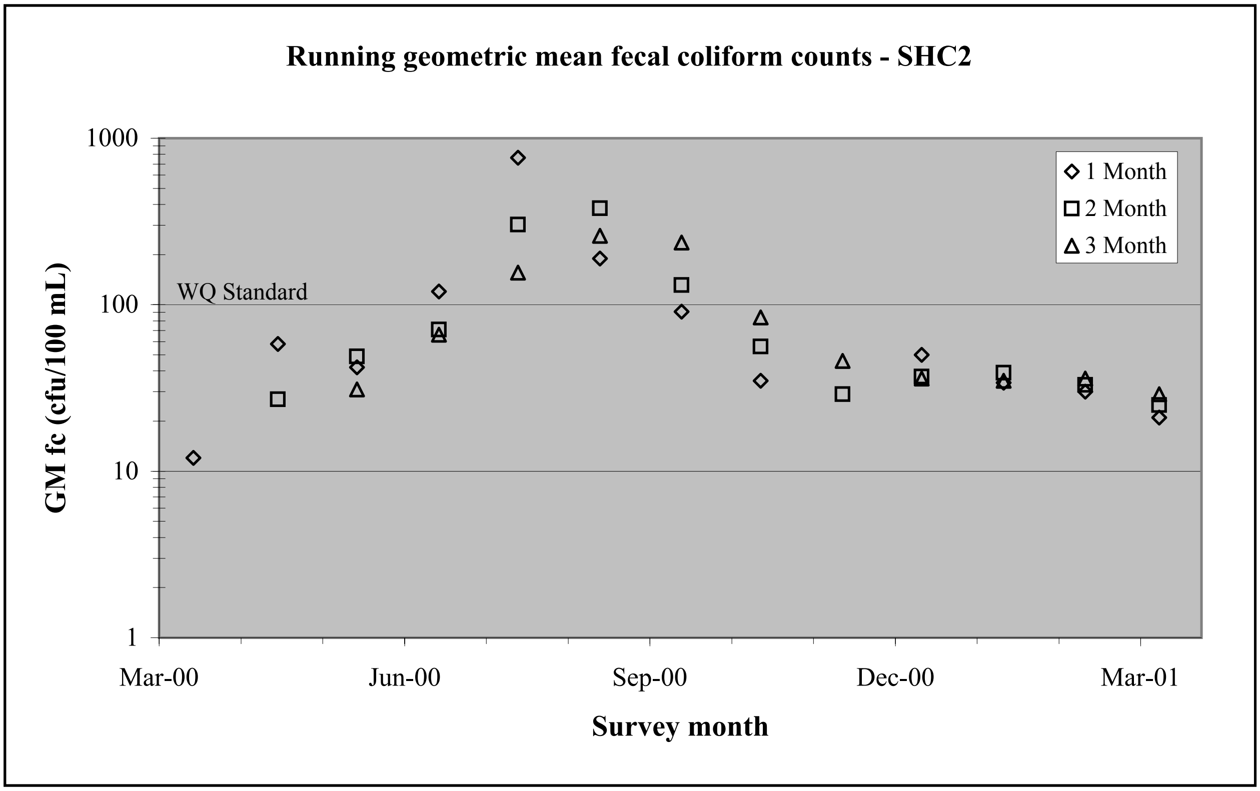


Figure A37. Running geometric mean and 90th percentiles for site SHC1.



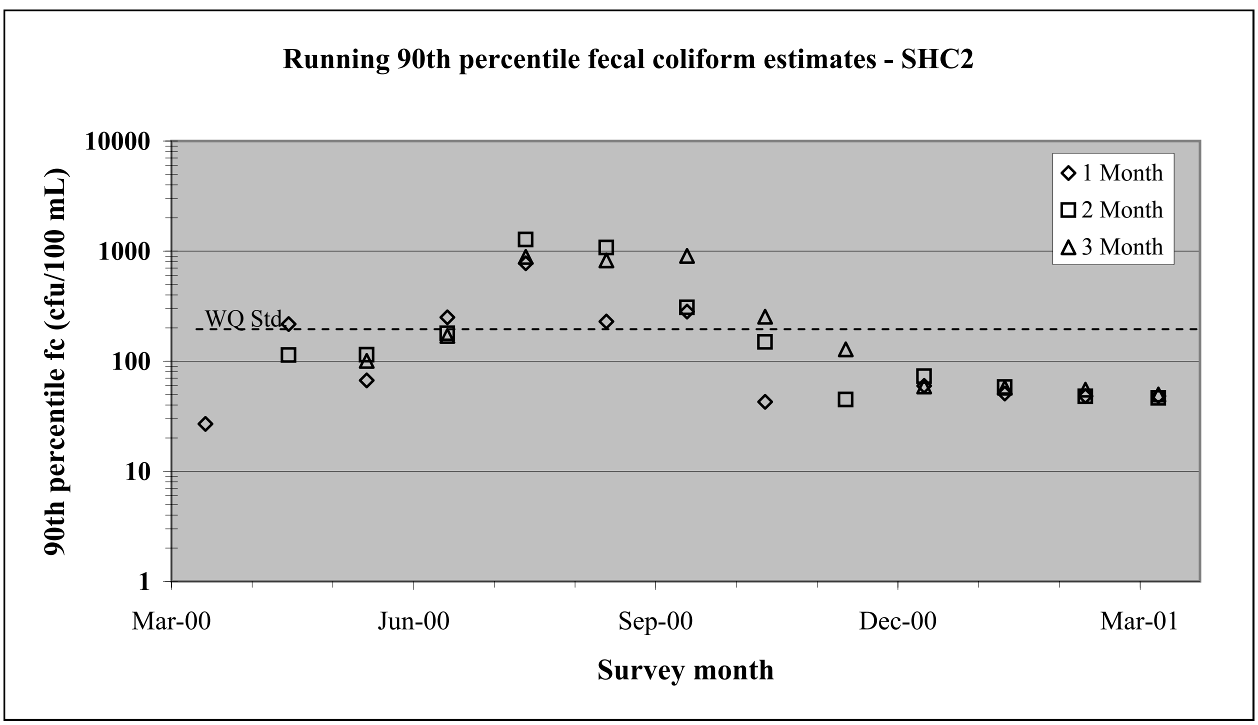
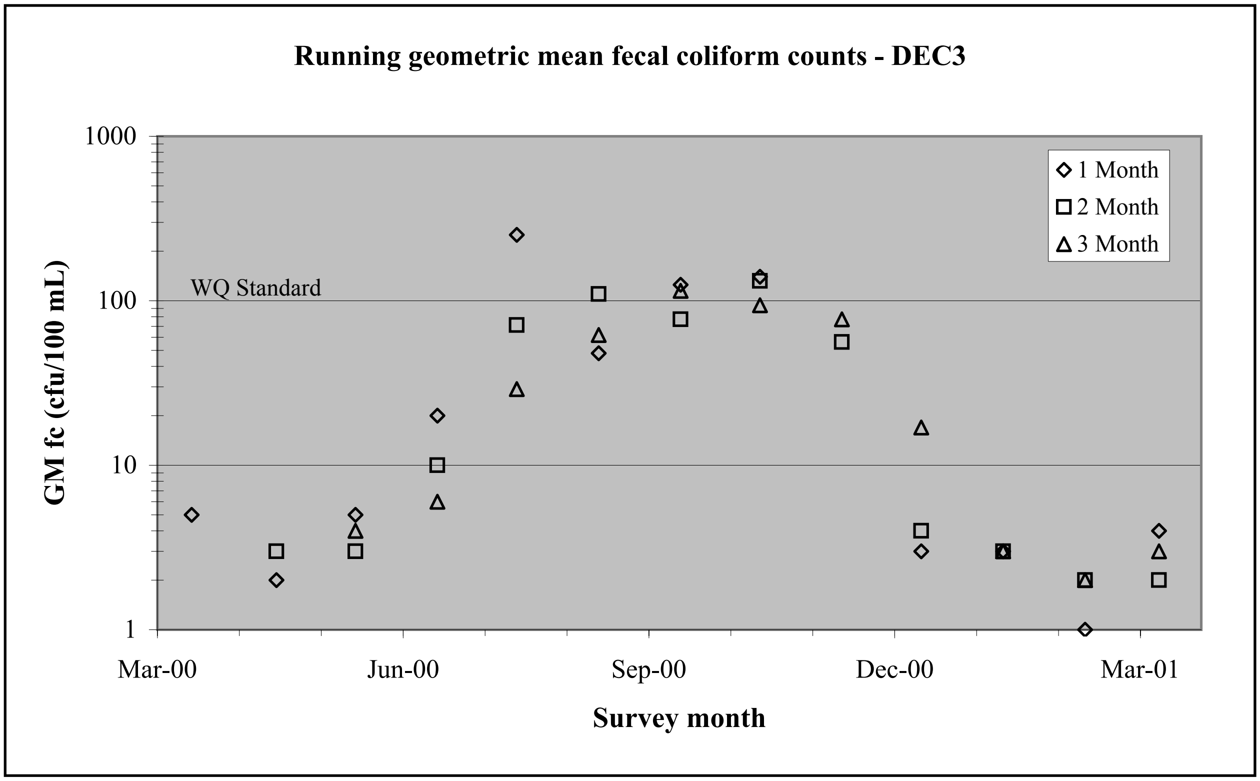


Figure A38. Running geometric mean and 90th percentiles for site SHC2.



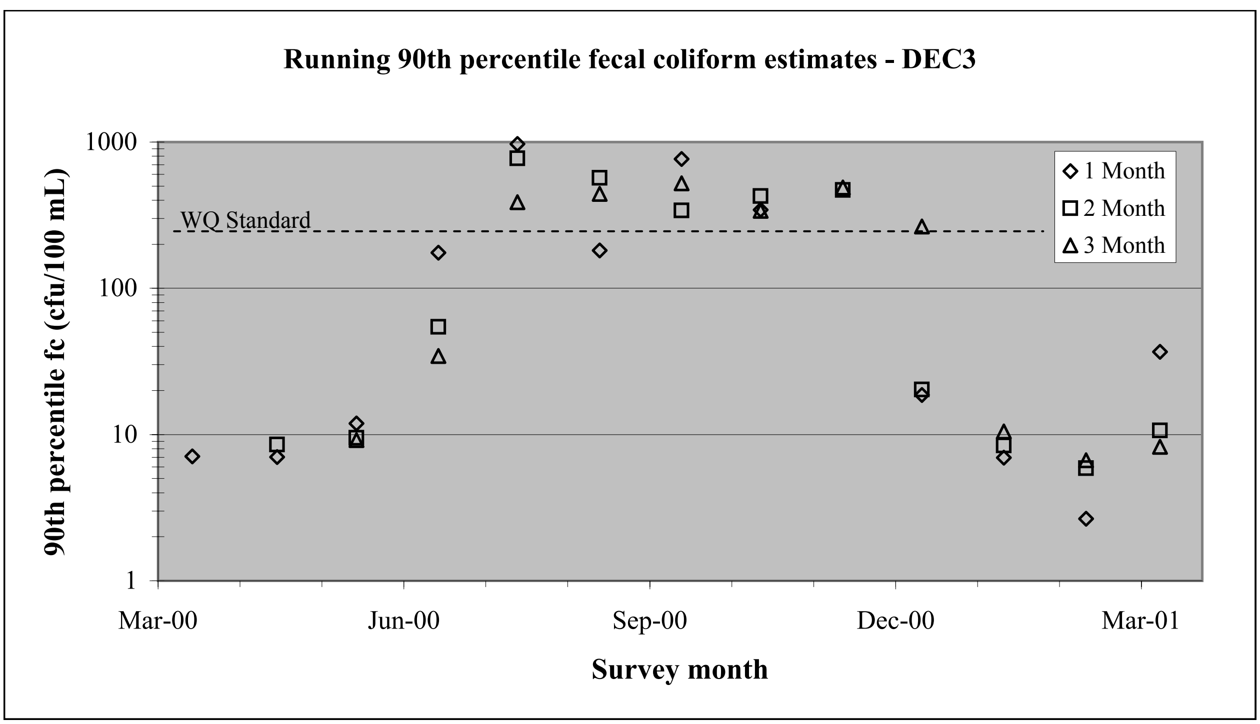
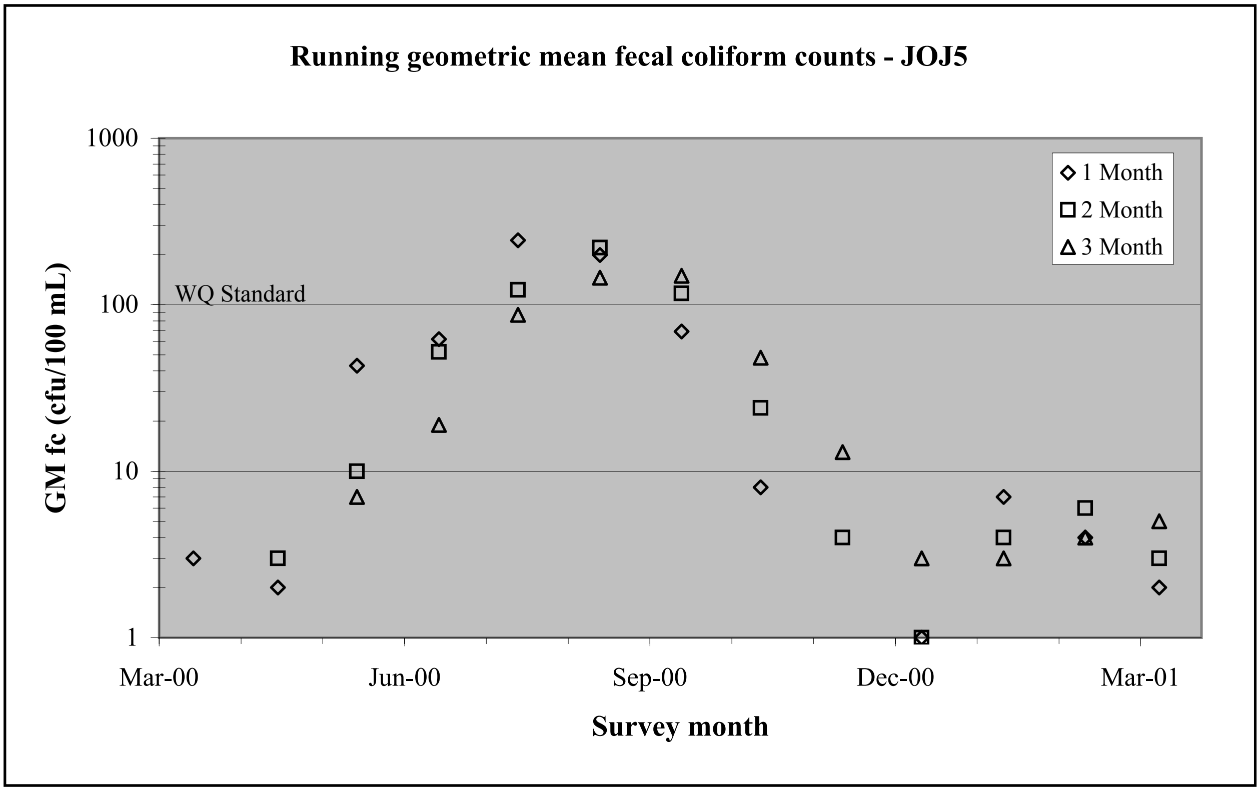


Figure A39. Running geometric mean and 90th percentiles for site DEC3.



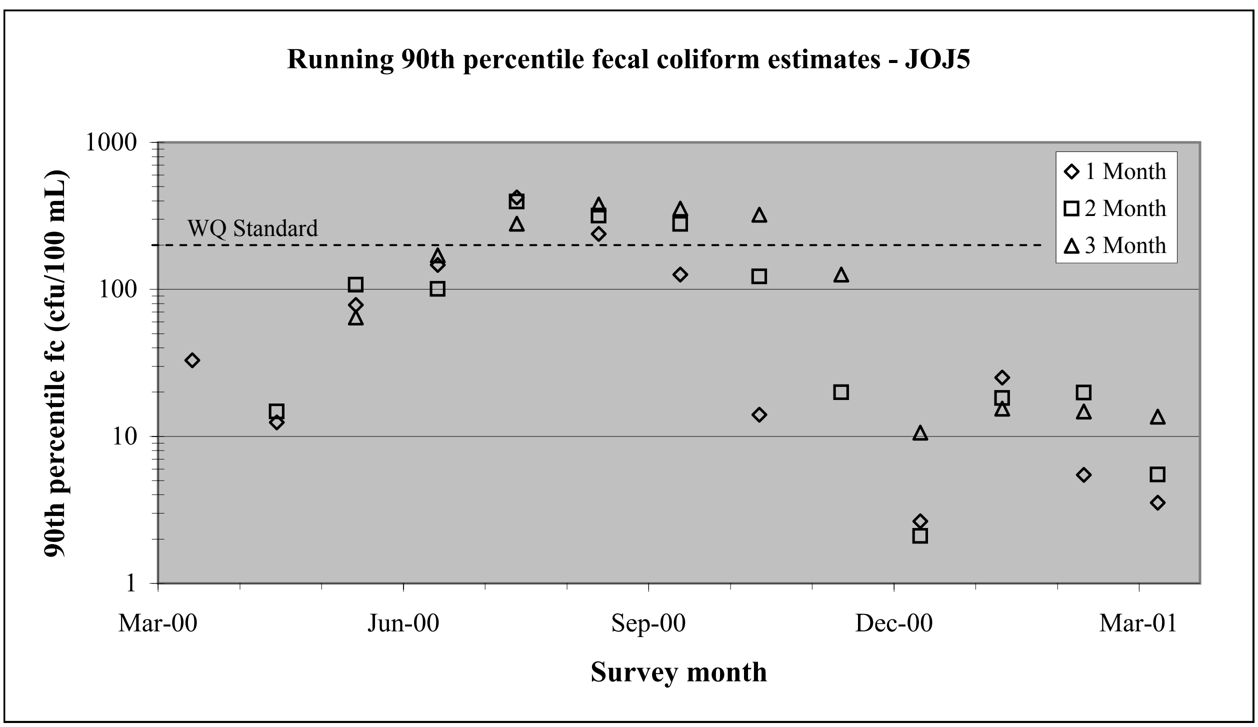
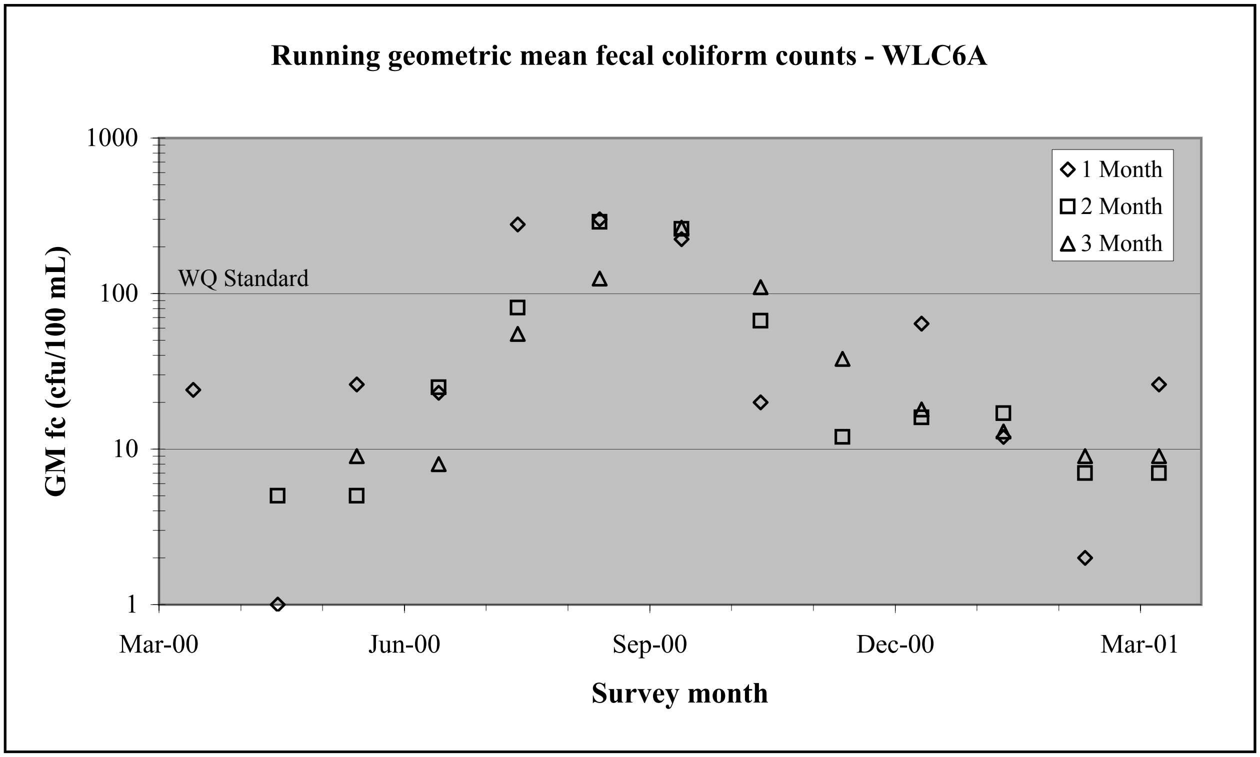


Figure A40. Running geometric mean and 90th percentiles for site JOJ5.



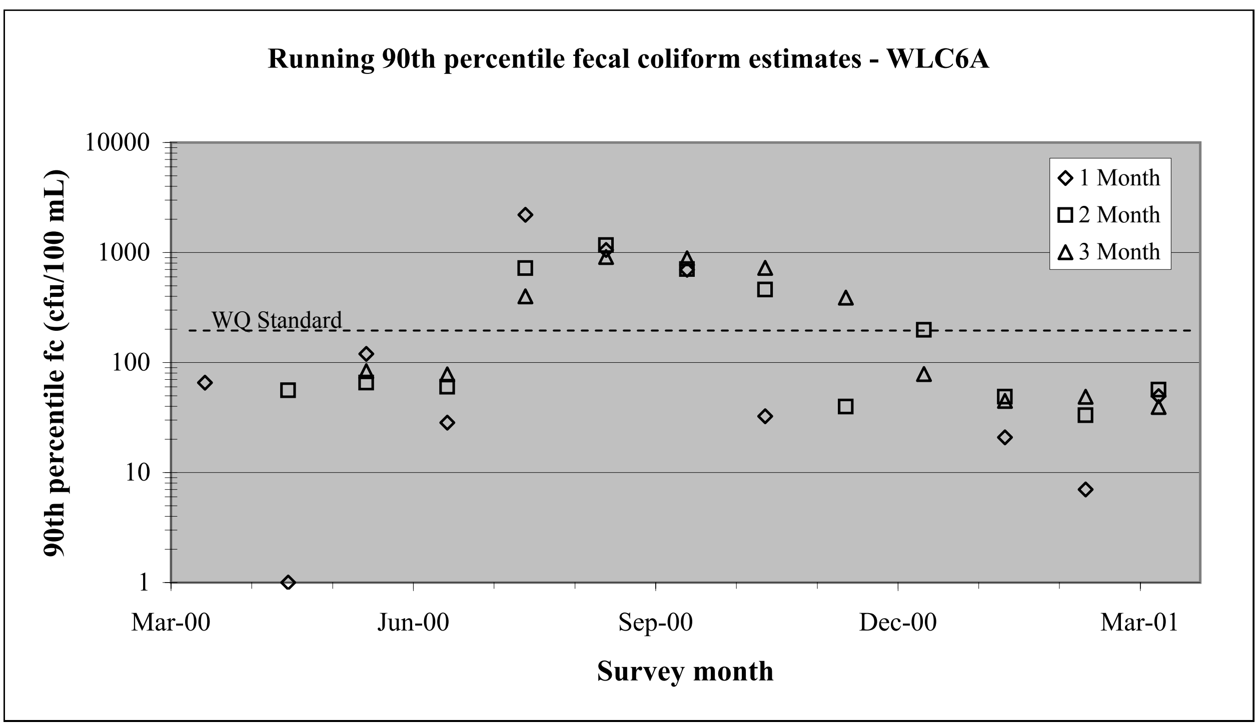
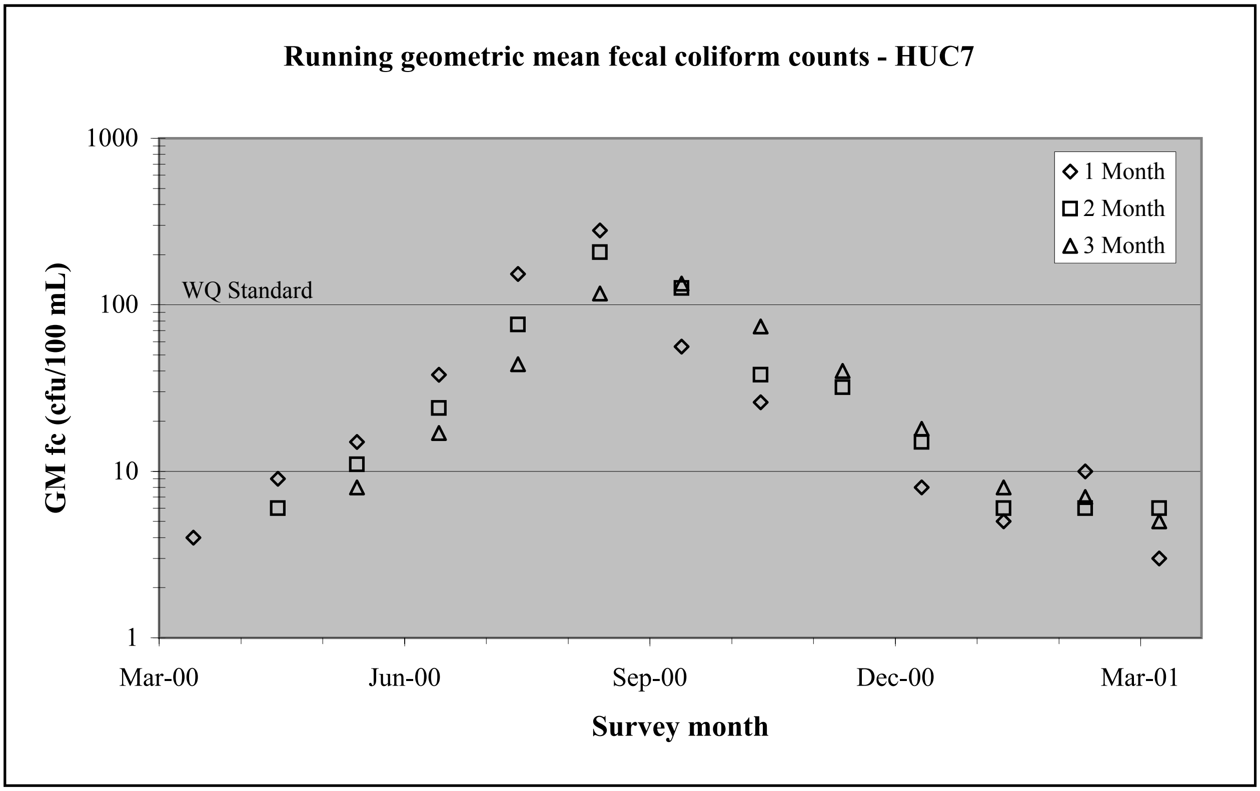


Figure A41. Running geometric means and 90th precentiles for site WLC6A.



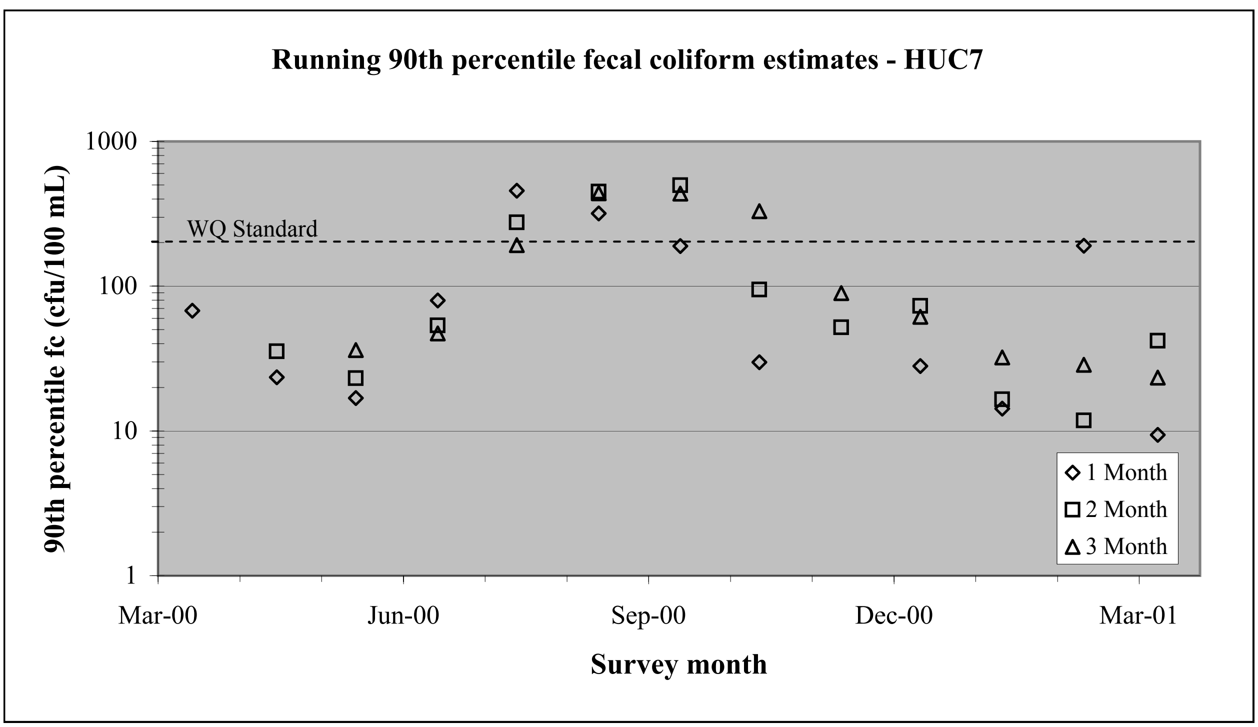
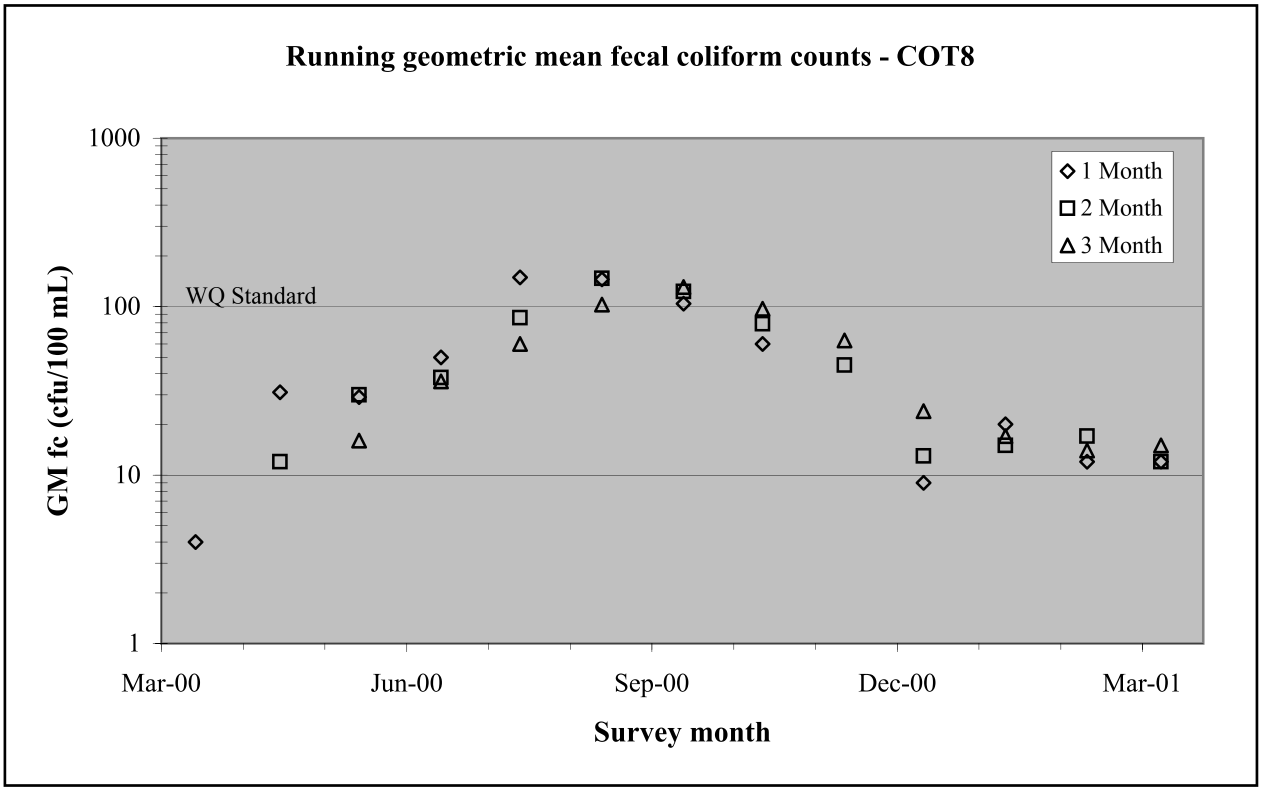


Figure A42. Running geometric means and 90th percentiles for site HUC7.



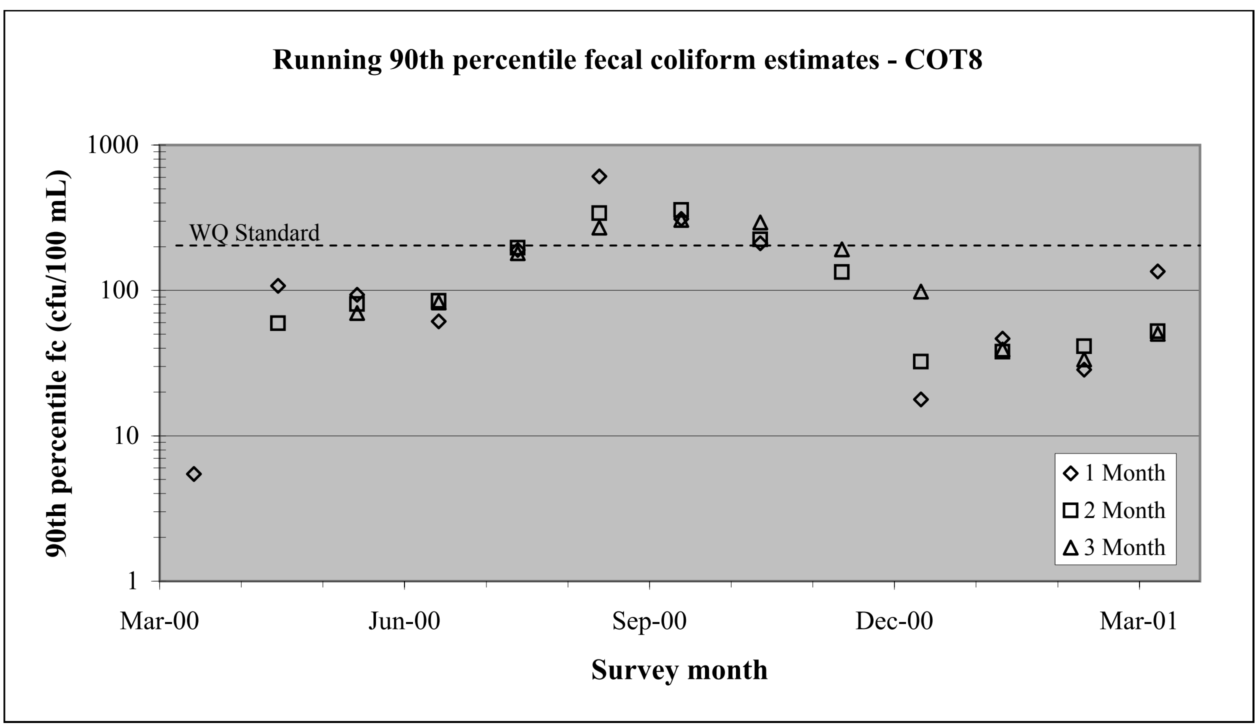
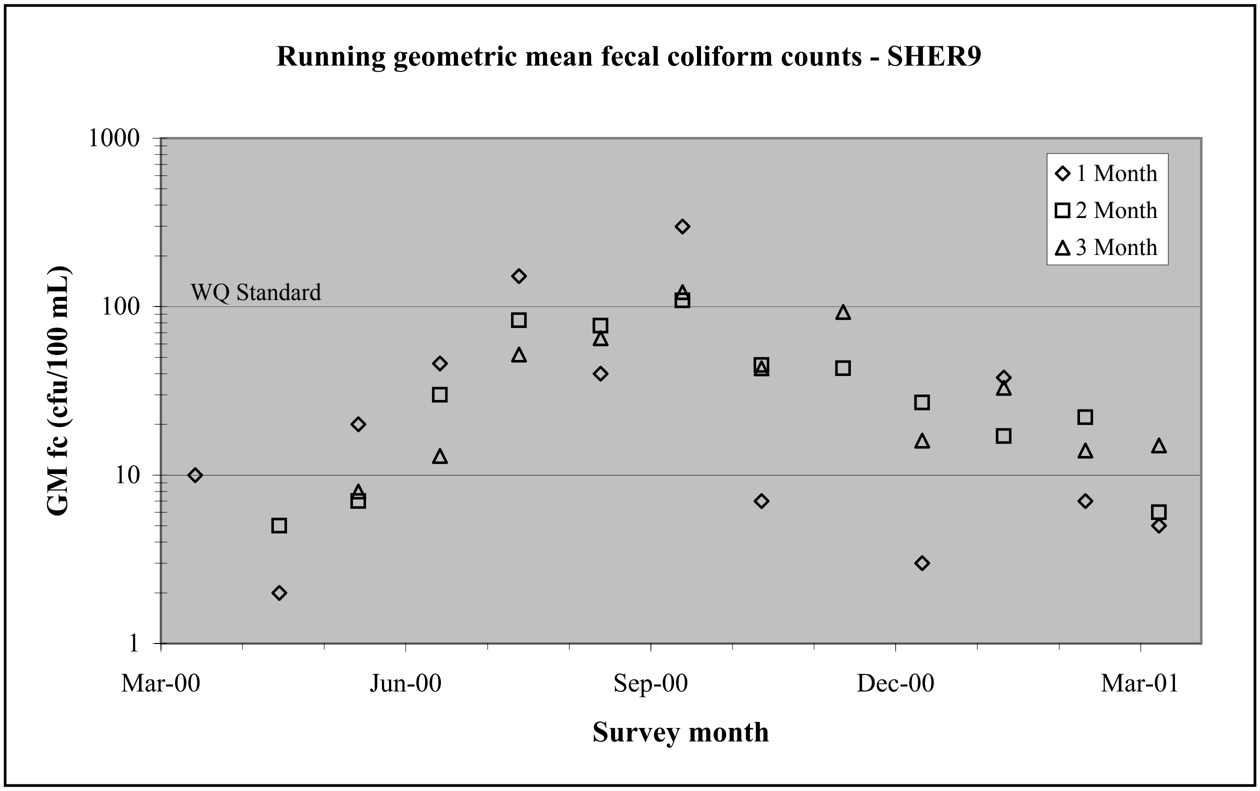


Figure A43. Running geometric mean and 90th percentiles for site COT8.



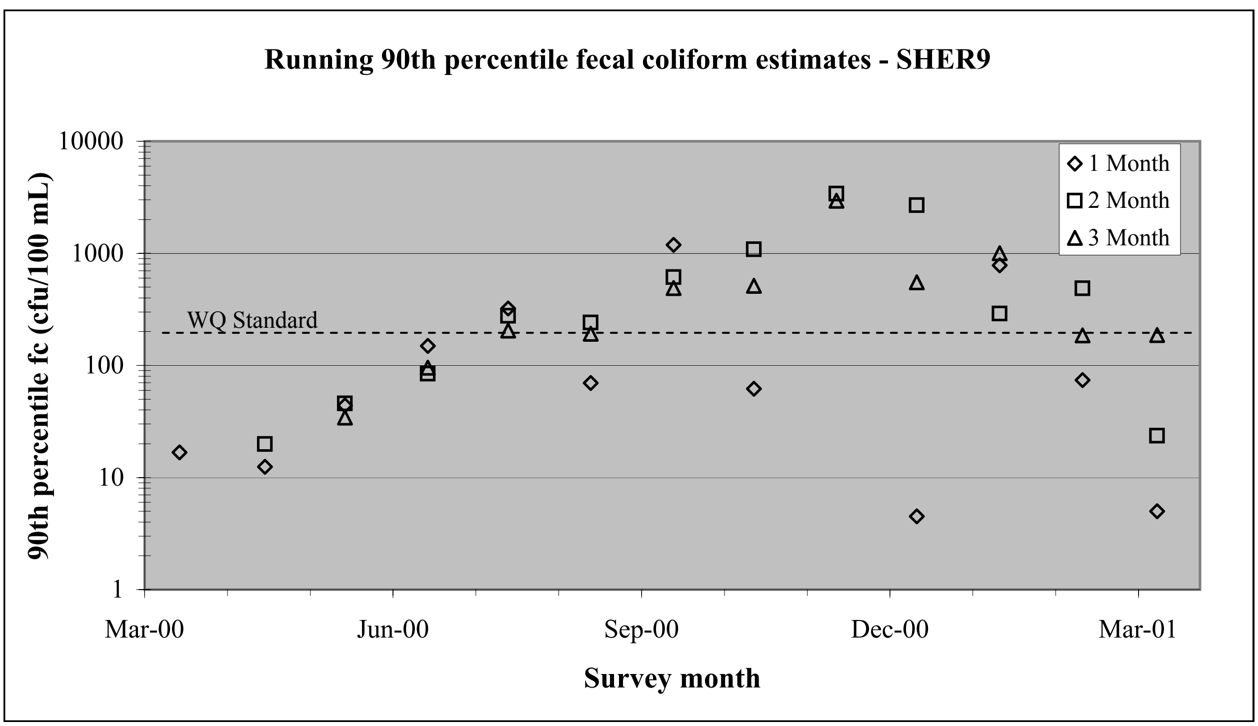
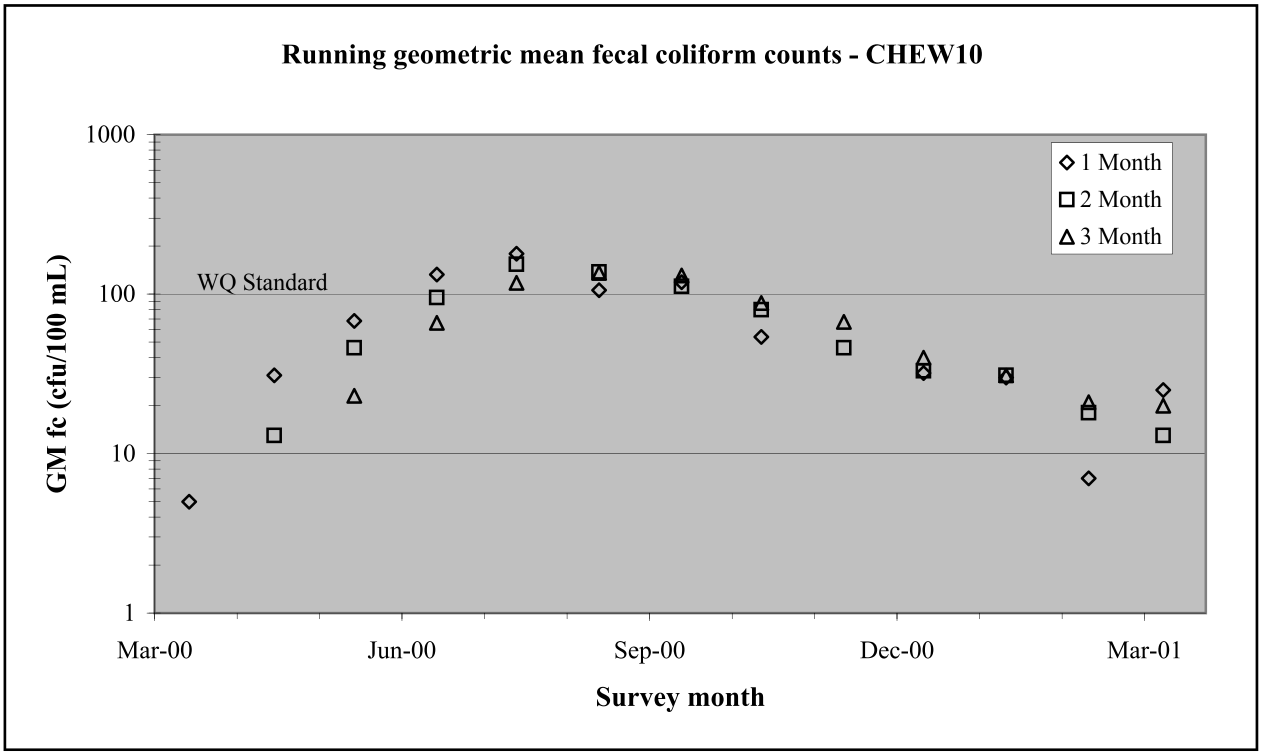


Figure A44. Running geometric mean and 90th percentiles for site SHER9.



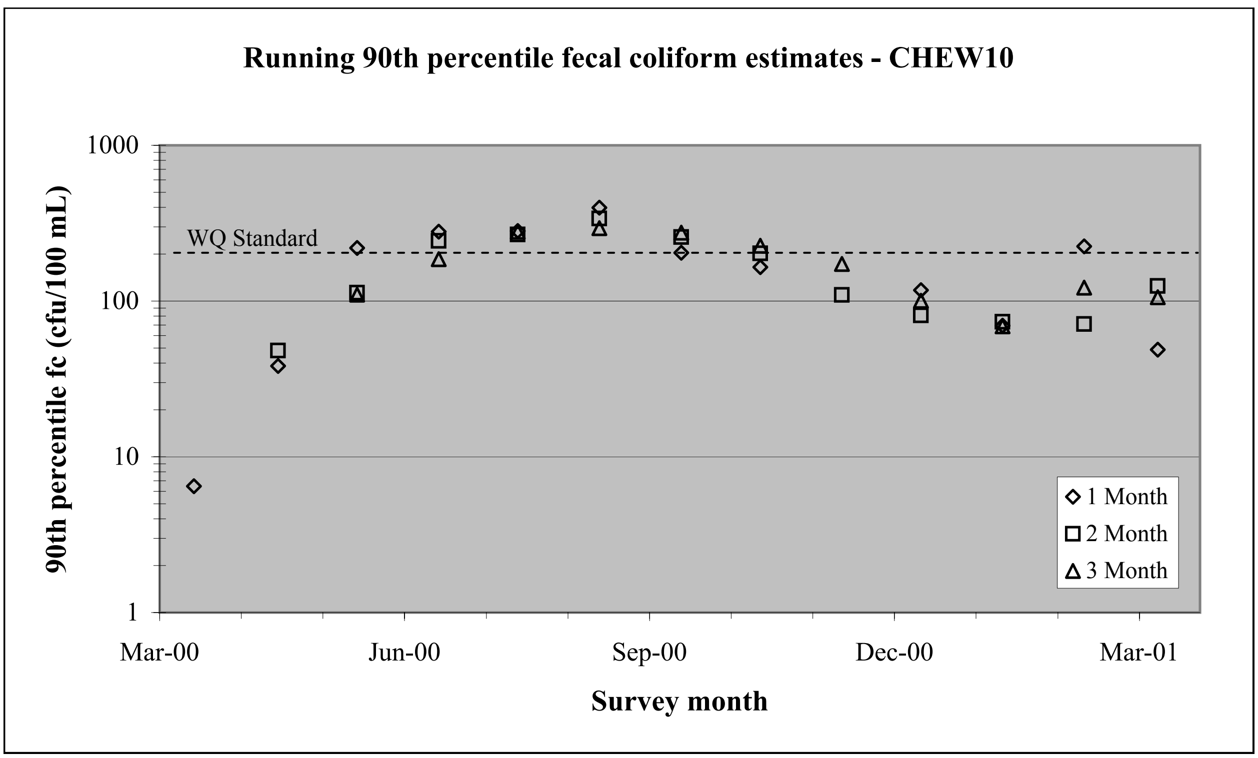
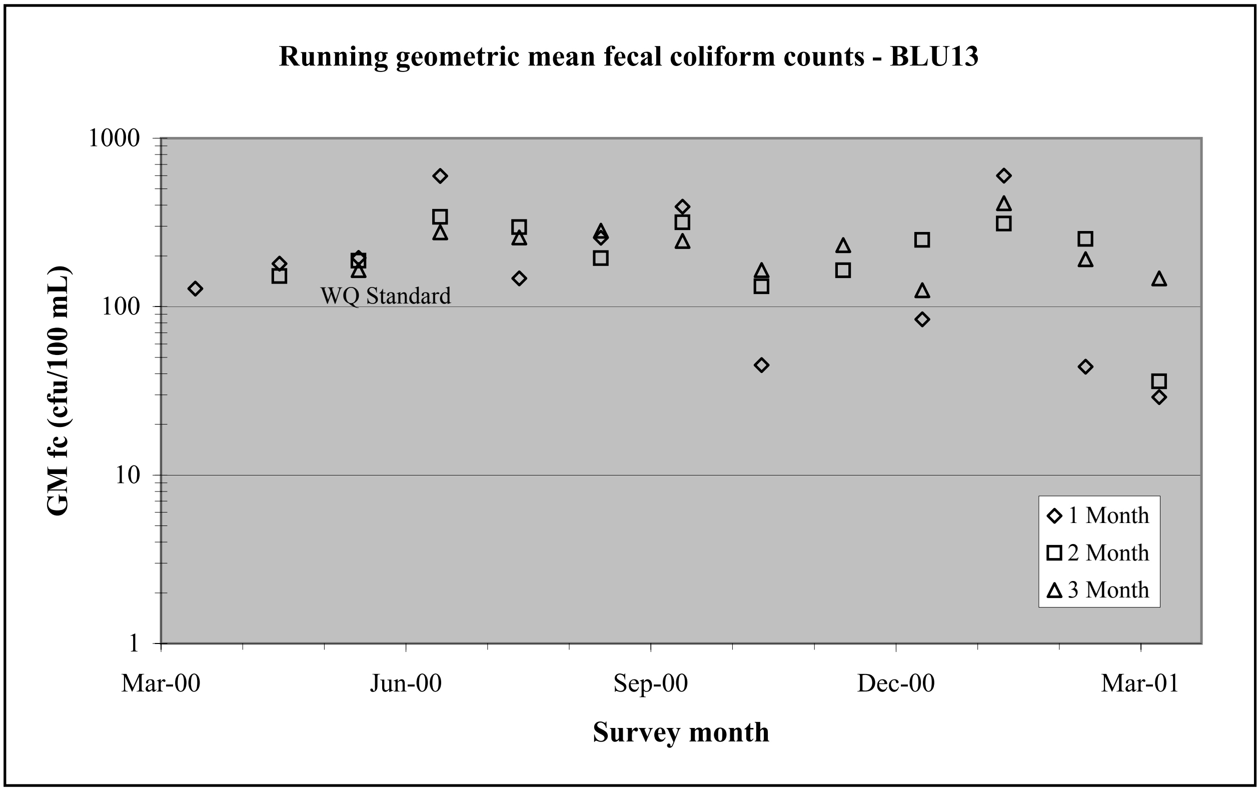


Figure A45. Running geometric mean and 90th percentiles for site CHEW10.



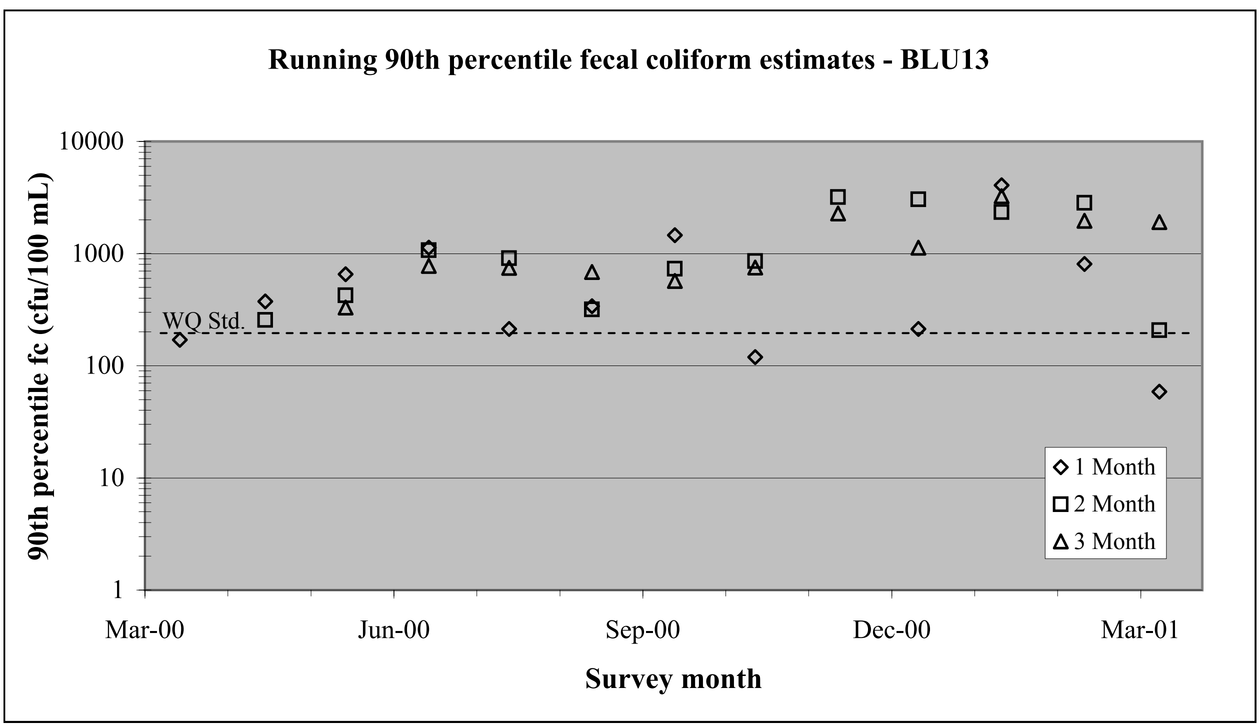
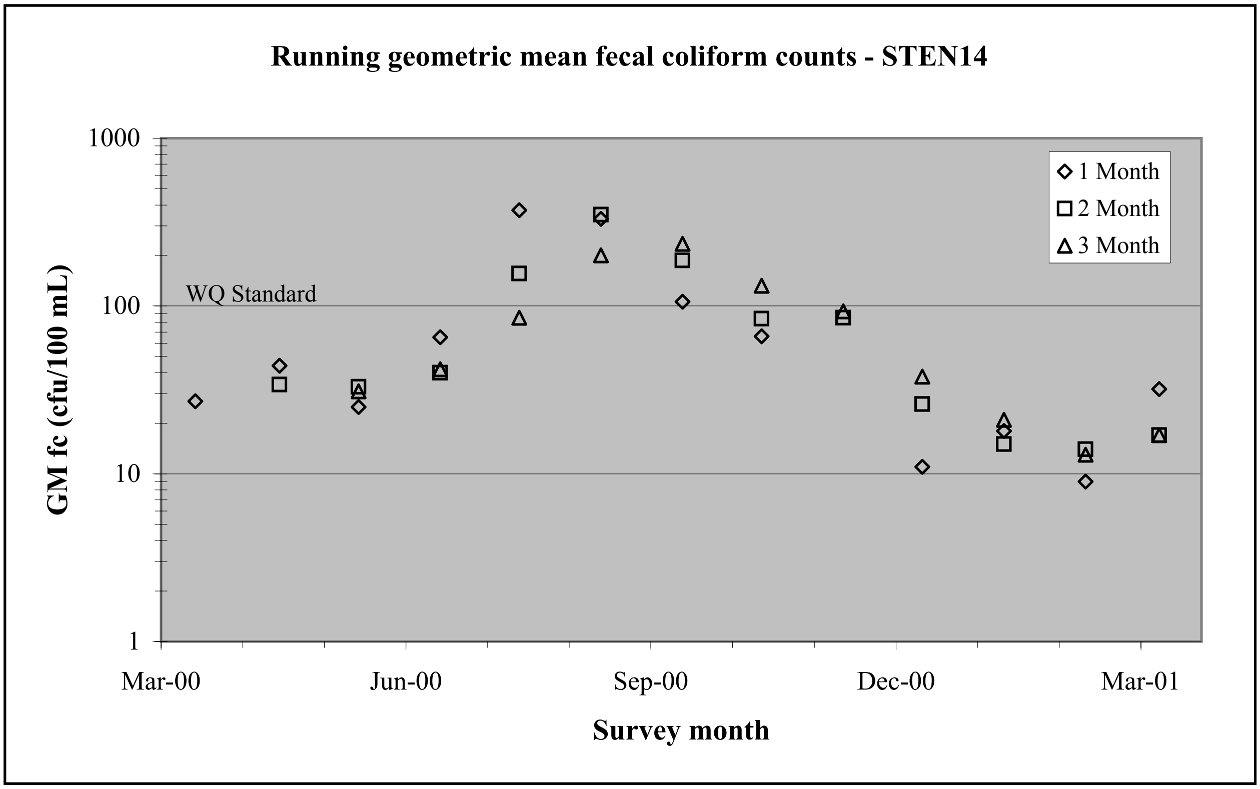


Figure A46. Running geometric mean and 90th percentiles for site BLU13.



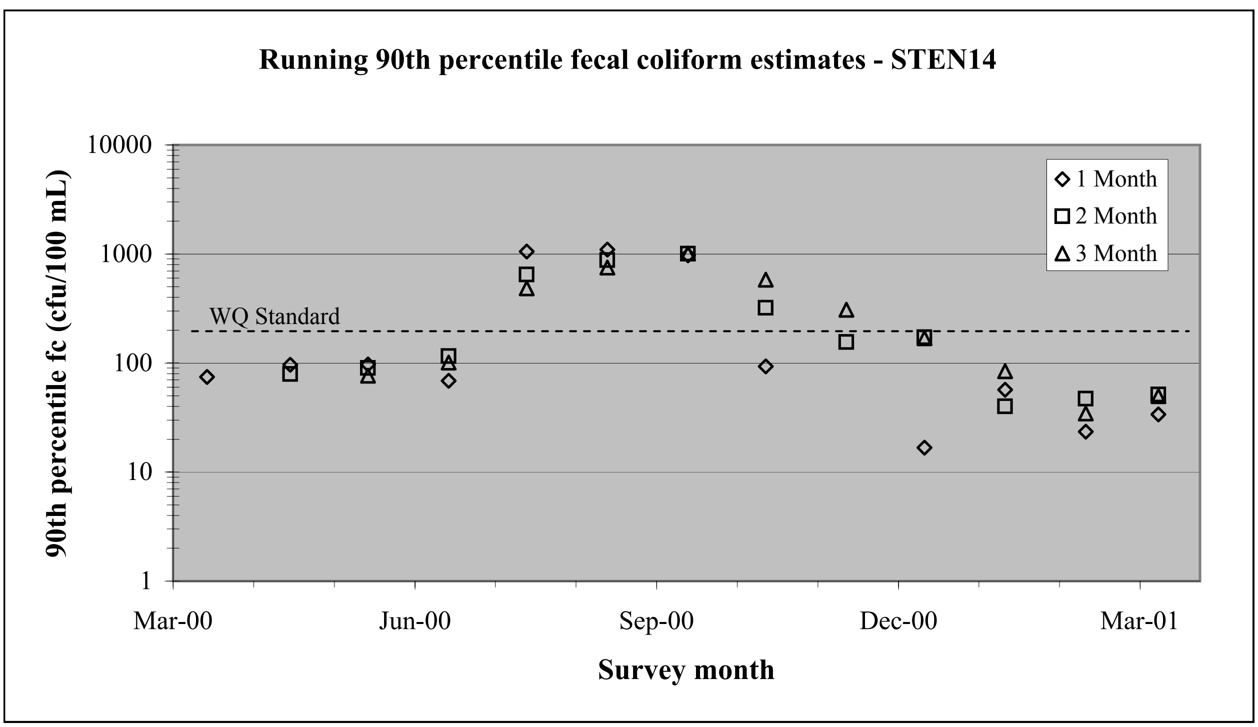
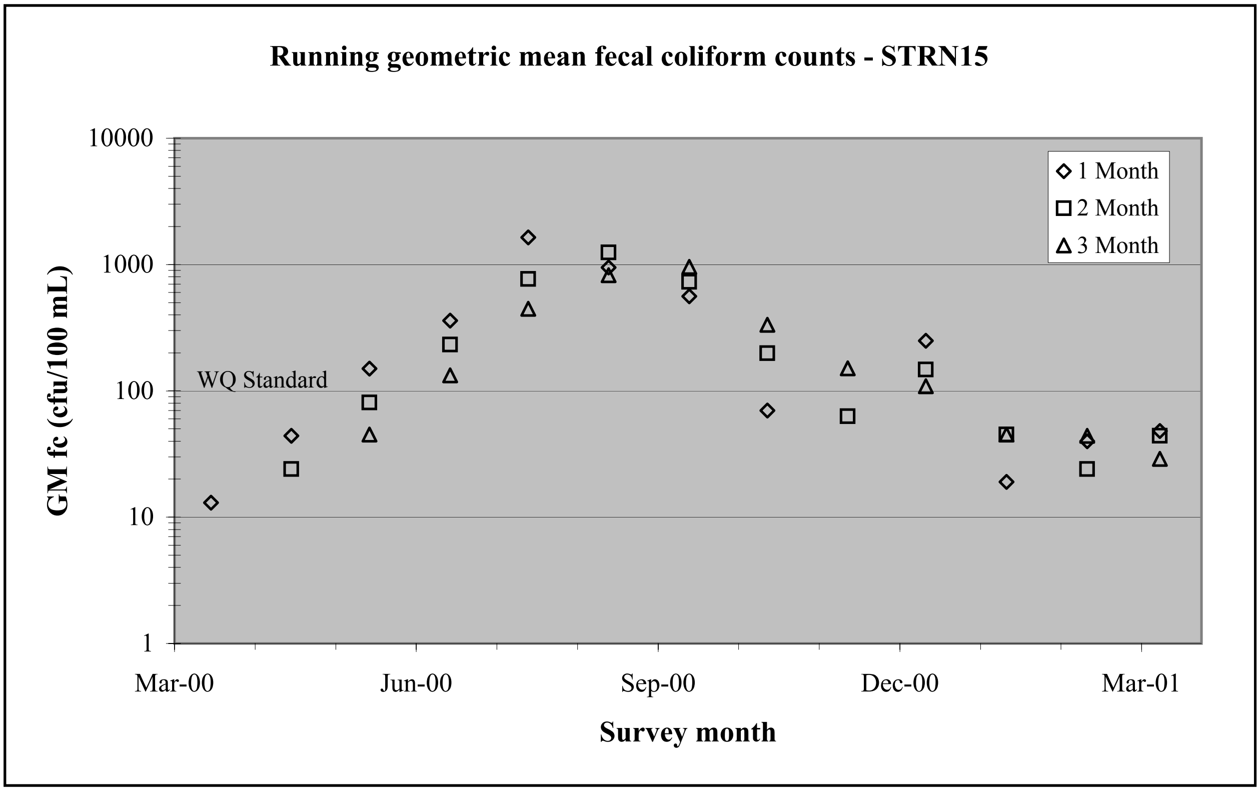


Figure A47. Running geometric mean and 90th percentiles for the site STEN14.



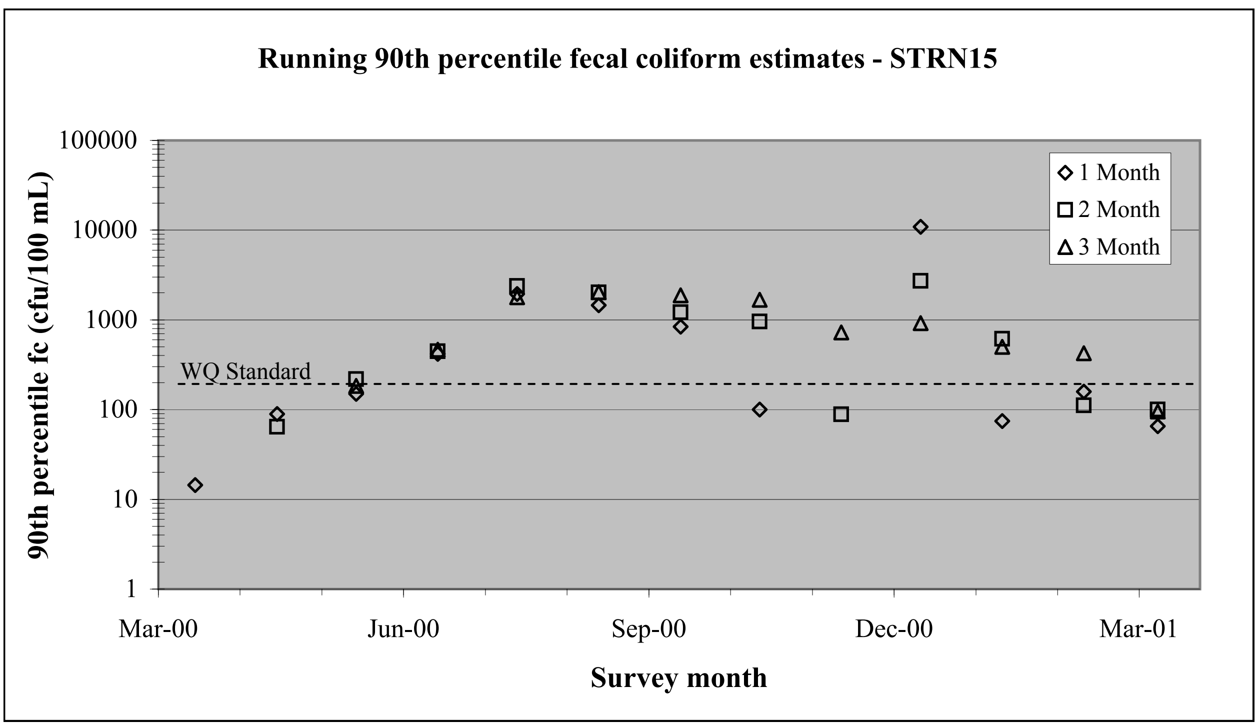
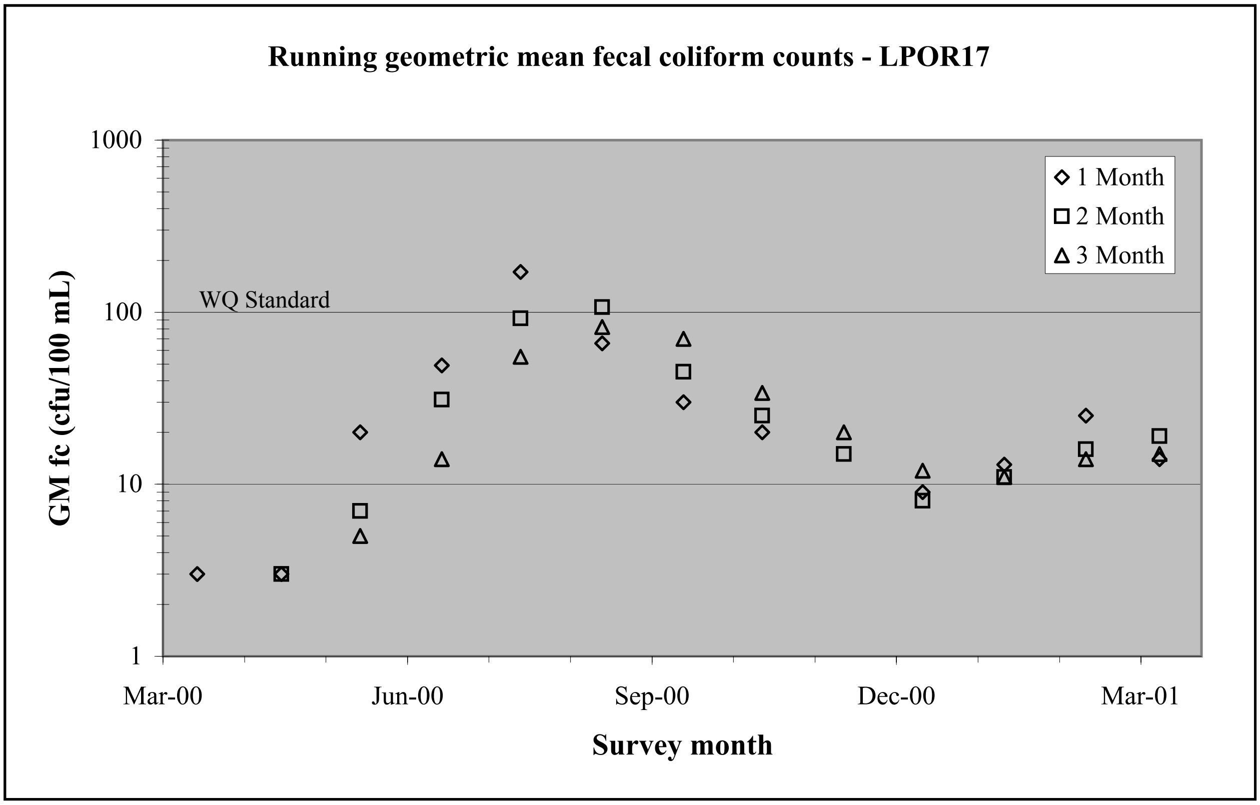


Figure A48. Running geometric mean and 90th percentiles for the site STRN15.



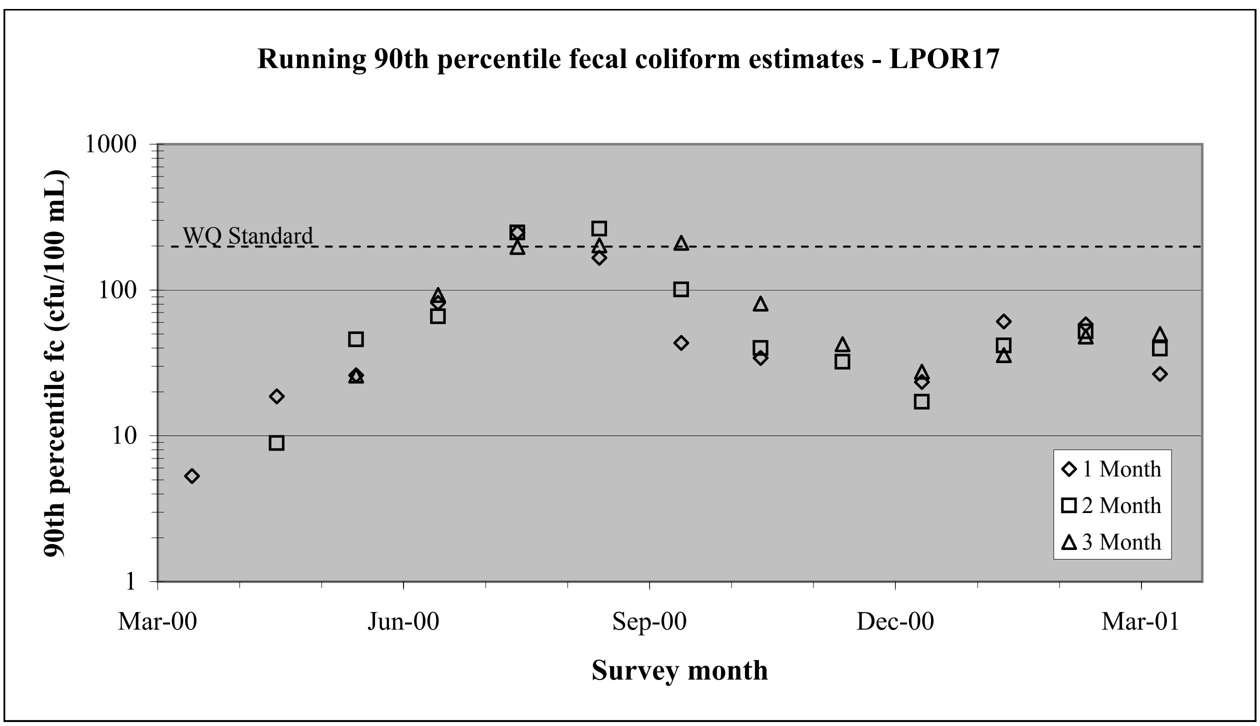
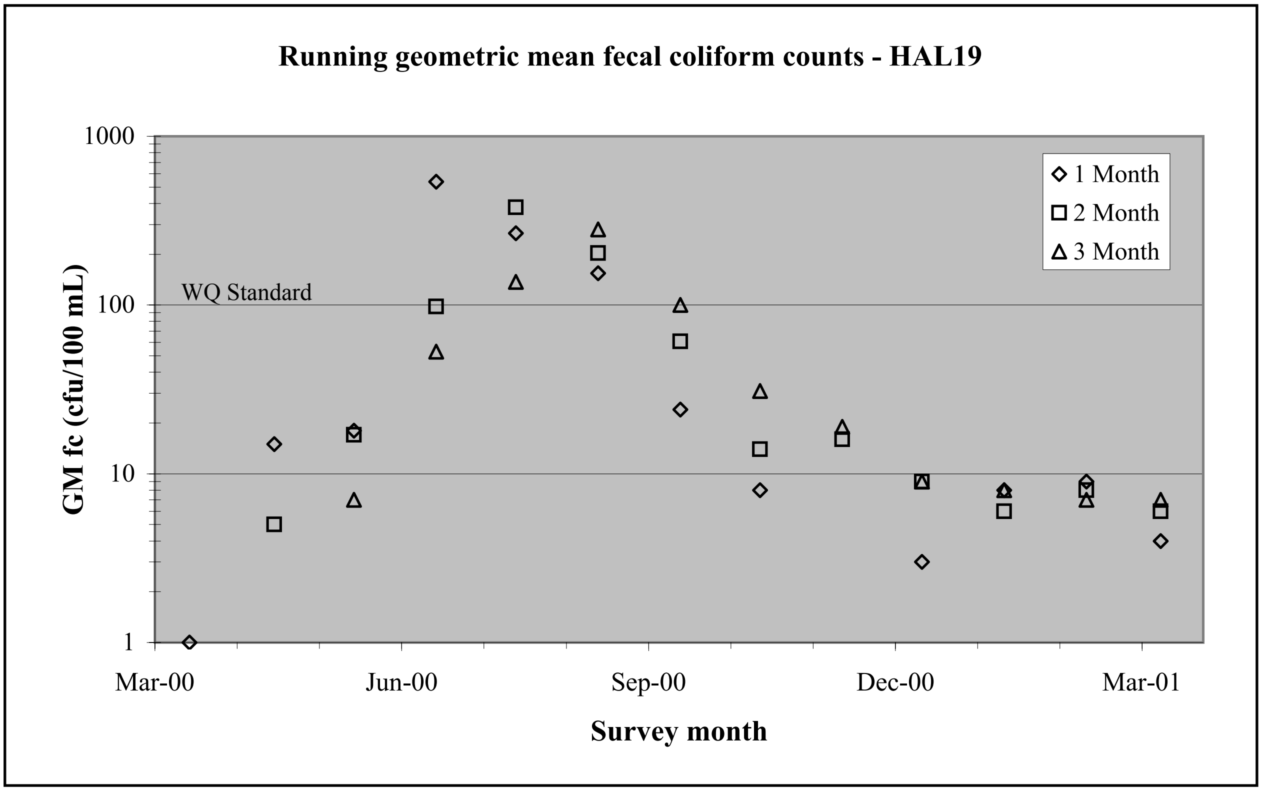


Figure A49. Running geometric mean and 90th percentiles for the site LPOR17.



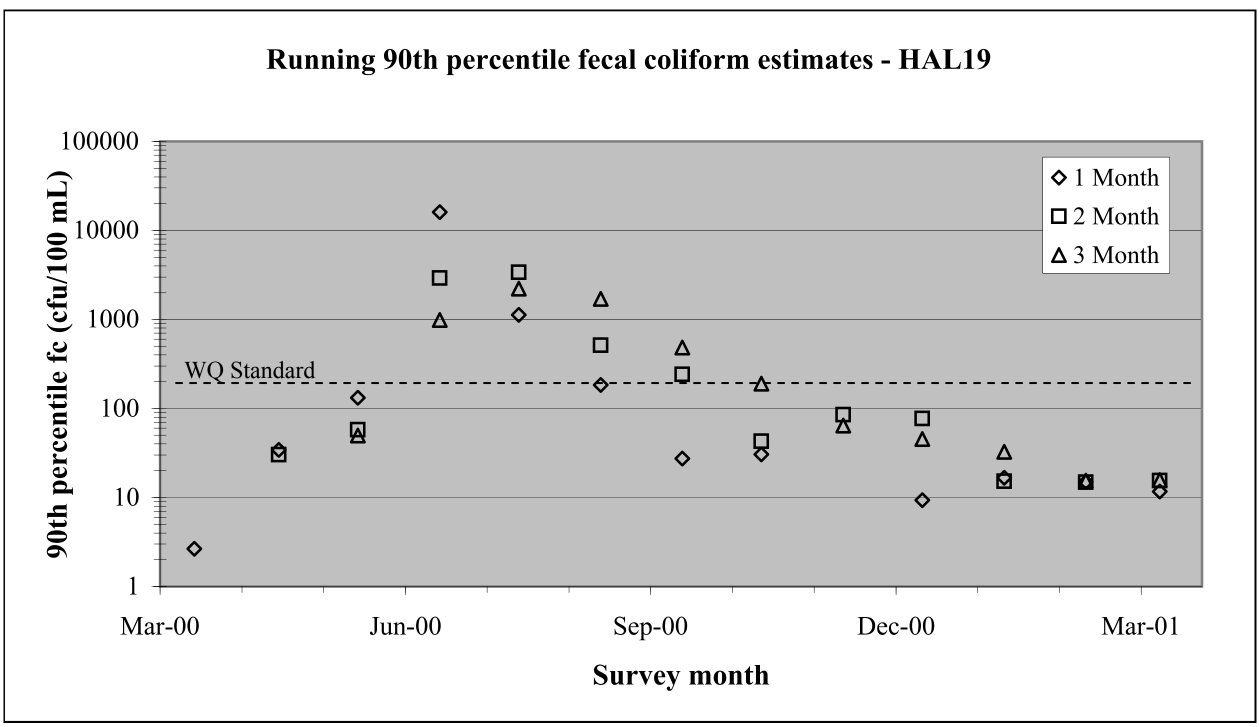
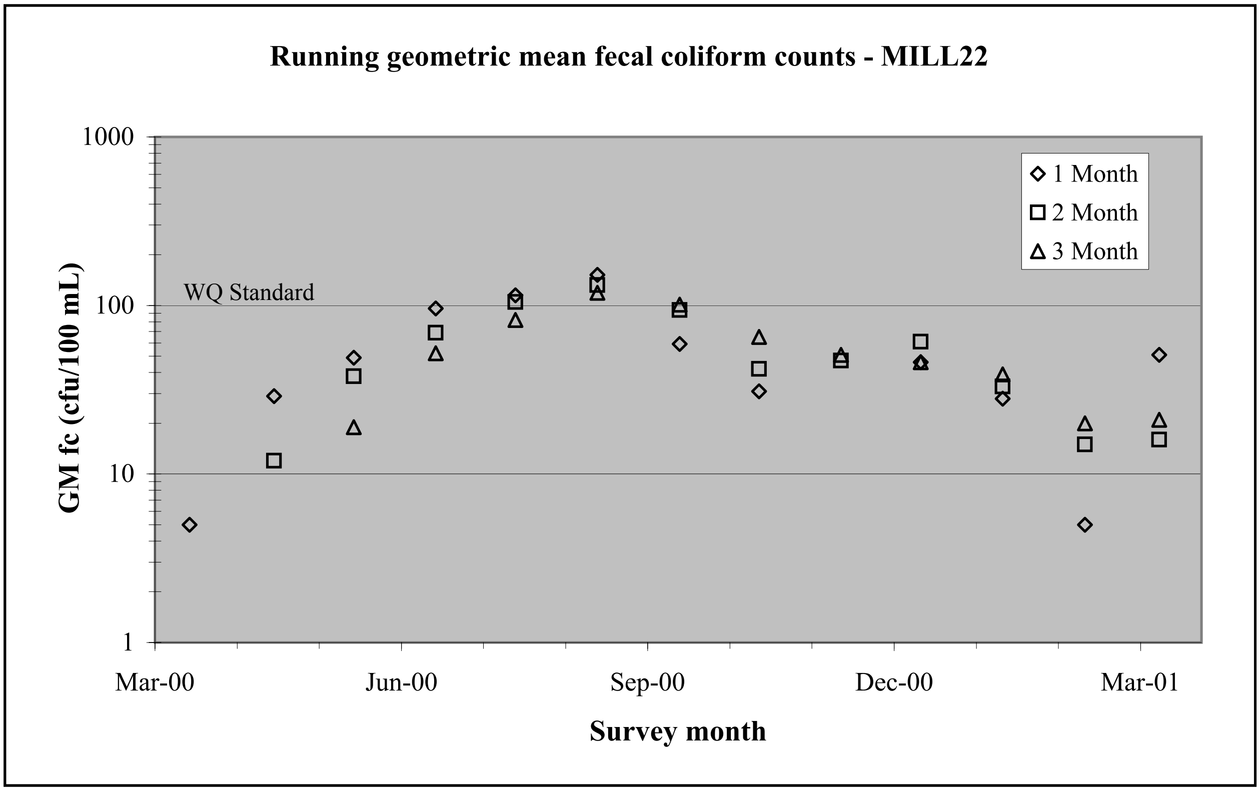


Figure A50. Running geometric mean and 90th percentiles for the site HAL19.



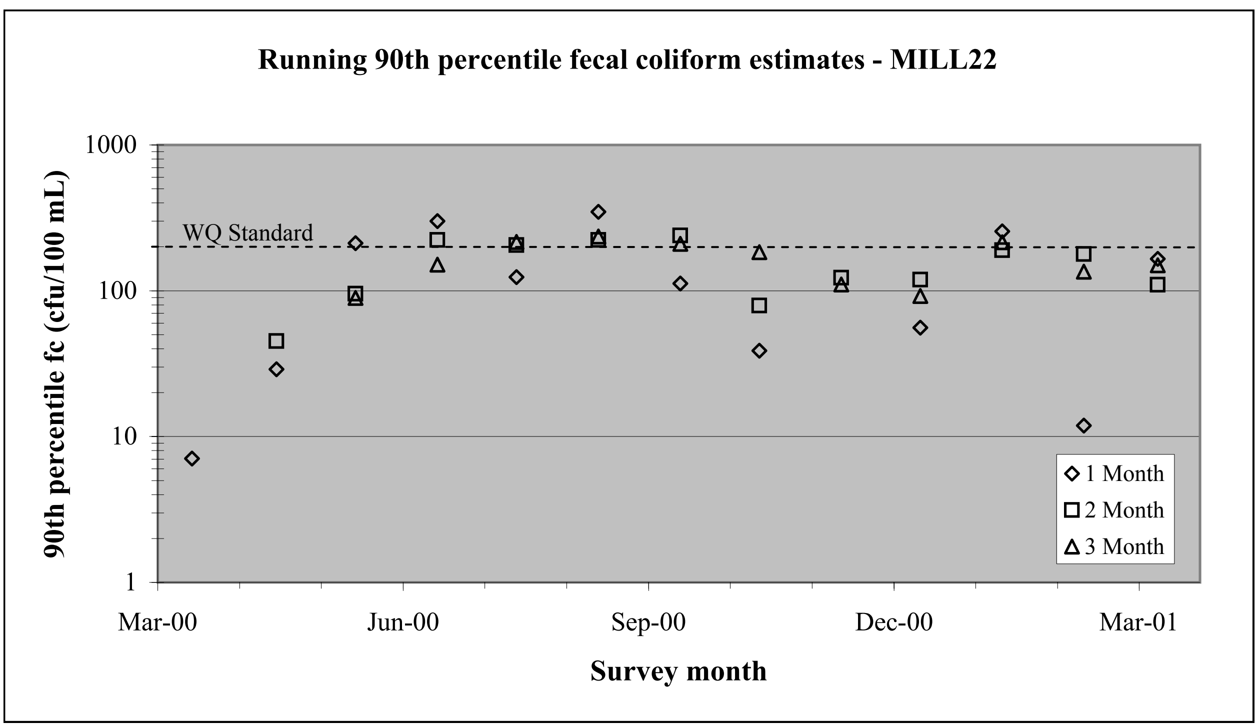


Figure A51. Running geometric mean and 90th percentiles for the site MILL22.

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Appendix B

Tables

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Table B1. Fecal coliform results for the Colville River Fecal Coliform TMDL Study, March 13, 2000 - March 27, 2001.

DATE	CR 24	CR 23	MILL22	CR 21	CR 20	HAL 19	CR 18	LPOR 17	CR 16	STRN 15	STEN 14	BLU 13	CR 12	CR 11	CHEW 10	SHER 9	COT 8	HUC 7	WLC6A	CR 6	JOJ 5	CR 4	DEC 3	SCH 2	SCH 1
3/13/00	6	3U	6	11	6	1U	6	2	8	14	47	**110**	15	9	5	13	4	1U	14	3	1U	3	6	8	5
3/27/00	5	16	4	5	5	2	6	4	8	13	15	**150**	21	5	6	7	5	20	42	7	12	15	4	19	20
4/10/00	40	15	29	14	15	24	27	1	24	30	29	**120**	38	4	35	1U	16	15	1U	15	1U	30	4	28	24
4/24-25/00	23	13	29	23	22	10	39	8	26	65	68	**270**	39	28	28	6	62	5	1	54	6	95	1U	**120**	46
5/8-9/00	17	10	22	8	30	6	24	17	39	**150J**	53	**380**	24	38	36	13	15	16	60	36	31	56	3	32	27
5/22-23/00	54	90	**110**	53	61	54	63	23	**110**	**150**	12	100	**170**	**120**	**130**	31	55	14	11	**270J**	60	**260J**	8	54	22
6/5-6/00	61	59	**180**	69	86	83	**120**	65	**170**	**330**	67	**850**	**210**	**230**	**200**	88	56	25	26	**260**	39	**360**	6	80	19
6/19-20/00	88	44	51	**110**	47	**3500J**	43	37	69	**390**	63	**420**	**180**	84	88	24	45	57	21	**370**	100	**480**	66	**180**	44
7/17-18/00	92	**130**	**120**	92	**170**	**120**	**360**	**140**	**180**	**1500**	**210**	120	**220**	**210**	**140**	100	**130**	84	89	**380**	**180**	**560**	**120**	**760**	82
7/31-8/1/00	44	**140**	**110**	**190**	**330**	**590**	**200**	**210**	**220**	**1800**	**660**	180	**280**	**260**	**230**	**230**	**170**	**280**	**870**	**700**	**330**	**1400**	**530**	**770**	**160**
8/14-15/00	81	**140**	96	96	**250**	**170**	**130**	**110**	**130**	**1200**	**640**	**220**	**140**	**240**	**220**	54	66	**300**	**600**	**530**	**180**	**1100**	100	**210**	**120**
8/28-29/00	100	**180**	**240**	**230**	**150**	**140**	**140**	40	**180**	**750**	**170**	**300**	**180**	**160**	51	29	**320**	**260**	**150**	**400**	**220**	**340**	23	**170**	31
9/11-12/00	**160**	**590**	84	**120**	**110**	26	**260**	37	**320**	**700**	**360**	**190**	**360**	**410**	**160**	**140**	**190**	**110**	**420**	**390**	96	**480**	**340**	**170**	21
9/25-26/00	57	38	41	46	96	23	29	25	34	**450**	31	**810**	**110**	**120**	88	**640J**	57	29	**120**	**250**	49	**260**	46	49	19
10/10-11/00	10	3	35	2	21	4	31	27	57	85	80	77	68	43	100	23	30	24	26	31	11	**210**	85	39	10
10/23-24/00	10	9	27	1	84	17	44	15	39	57	55	26	57	92	29	2	**120**	28	15	44	6	**150**	**230**	31	8
11/6-7/00	2	3	**110**	1U	16	56	27	8	24	51	**140**	**2200**	27	26	33	**1700**	26	49	4	29	1U	54	9	20	6
12/4-5/00	54	2	41	1U	4	2	6	5	96	**2000J**	9	50	35	44	16	3	6	4	64	**140**	2	**120**	1U	55	49
12/18-19/00	1U	2	51	1U	**	6	66	15	**150**	31	14	**140**	**200**	**	66	4	13	16	**	88	1U	80	8	45	52
1/2-3/01	42	55	**120**	**120**	5	8	9	20	31	92	46	**790J**	34	84	73	5	37	8	8	**540**	6	48	4	23	41
1/15-16/01	1U	1U	10	1U	1U	18	2	26	8	14	8	**440**	19	28	25	10	12	12	22	**170**	3	43	3	34	33
1/22-23/01	3	1	4	2	1	5	1	2	3	11	8	100	33	36	29	43	34	2	11	**150J**	5	37	5	49	26
1/29-30/01	33	6	**120**	3	17	6	28	24	11	9	32	**3700J**	26	31	15	**1000J**	11	3	11	**250**	29	34	1	36	37
2/13-14/01	36	25	3	65	10	7	13	16	14	86	15	**220**	9	2	47	26	19	2	1	4	4	2	2	23	44
2/26-27/01	14	4	8	48	10	12	9	40	2	19	5	9	88	1U	1U	2	7	51	4	58	5	12	1U	39	37
3/12-13/01	12	27	98	**120**	8	7	17	20	9	41	31	20	18	38	36	5	45	2	18	95	2	39	1	13	10
3/26-27/01	89	29	27	20	15	2	20	10	10	57	33	43	9	23	17	5	3	6	37	23	3	21	13	33	13

** = No sample - stream frozen
U = Analyte not detected at the detection limit shown
J = The number reported is an estimate, although the "true" value may be greater than or equal to the reported value
Bolded = Result is greater than the first criterion of the Class A water quality standard for fecal coliform bacteria (100 cfu/100 mL)
= Result is greater than the second criterion of the Class A water quality standard for fecal colidform bacteria (200 cfu/100 mL)

Table B2. E.coli results for the Colville River Fecal Coliform TMDL Study, March 13 - August 1, 2000.

DATE	CR 24	CR 23	MILL22	CR 21	CR 20	HAL 19	CR 18	LPOR 17	CR 16	STRN 15	STEN 14	BLU 13	CR 12	CR 11	CHEW 10	SHER 9	COT 8	HUC 7	WLC6A	CR 6	JOJ 5	CR 4	DEC 3	SCH 2	SCH 1
3/13/00	6	*	6	9	6	*	6	2	8	14	47	110	15	9	4	12	3	*	14	3	*	3	6	8	5
3/27/00	5	16	4	5	5	2	6	4	8	13	15	**150**	21	5	6	7	5	19	42	7	12	15	4	19	20
4/10/00	39	15	29	14	15	24	27	1	24	30	29	120	38	4	35	1U	15	15	1U	15	1U	30	3	28	24
4/24-25/00	23	11	28	23	21	10	39	8	22	65	61	**270**	39	27	28	6	62	5	1	54	6	95	1U	120	45
5/8-9/00	17	8	21	8	30	4	24	17	37	**150J**	53	**370**	24	37	36	13	13	16	60	35	28	56	3	29	27
5/22-23/00	54	86	84	50	54	52	60	20	95	120	12	96	**160**	120	120	21	36	14	11	**250J**	35	**250J**	8	49	21
6/5-6/00	56	51	**160**	67	80	83	120	65	**160**	**330**	67	**800**	**210**	**230**	**190**	85	53	22	21	**240**	39	**140**	6	80	19
6/19-20/00	88	44	49	110	45	**3500J**	43	36	69	**380**	61	**420**	**180**	80	88	24	44	57	15	**360**	100	**480**	58	**180**	40
7/17-18/00	92	110	120	88	**170**	120	**360**	**140**	**160**	**1500**	**190**	120	**220**	**200**	120	100	120	84	87	**340**	**180**	**530**	110	**760**	80
7/31-8/1/00	44	120	100	**160**	**300**	**590**	**170**	**210**	**220**	**1700**	**650**	**160**	**240**	**220**	**210**	**200**	**160**	**280**	**860**	**630**	**310**	**1400**	**530**	**770**	**150**

* = No analysis
U = Analyte not detected at the detection limit shown
J = The number reported is an estimate, although the "true" value may be greater than or equal to the reported value
Bolded = Result is greater than the first criterion of the "proposed" Class A water quality standard for E.coli bacteria (126 cfu/100 mL)
= Result is greater than the second criterion of the "proposed" Class A water quality standard for E.coli bacteria (406 cfu/100 mL)

Table B3. Enterococcus results for the Colville River Fecal Coliform TMDL Study, August 14, 2000 - March 27, 2001.

DATE	CR 24	CR 23	MILL22	CR 21	CR 20	HAL 19	CR 18	LPOR 17	CR 16	STRN 15	STEN 14	BLU 13	CR 12	CR 11	CHEW 10	SHER 9	COT 8	HUC 7	WLC6A	CR 6	JOJ 5	CR 4	DEC 3	SCH 2	SCH 1
8/14-15/00	16	88	190	19	39	80	43	92	41	370	250	240	120	44	59	52	110	130	610	360	280	540	150	160	76
8/28-29/00	23	80	88	57	29	100	80	44	84	1000	200	370	54	92	75	37	110	140	420	230	120	370	88	140	47
9/11-12/00	38	59	110	55	56	200	120	29	160	480	96	100	250	150	150	40	210	160	1800	440	100	510	260	180	40
9/25-26/00	24	88	840J	22	100	470	220	140	160	5400J	100	1200J	160	480	100	51	200	31	150	460	95	1400	37	240	96
10/10-11/00	1U	1U	3	1	1U	3U	3	1	6	740	11	69	88	100	160	9	210	190	260	210	37	310	84	140	63
10/23-24/00	1U	1U	11	1U	1	1U	1	1U	*	1500	210J	37	280	1100	63	4	3U	3U	3	3U	1	31	3	3	4
11/6-7/00	3	3	430J	8	150	120	310J	440	130	670	320	91	120	200	64	63	65	37	85	92	4	260	11	1300J	770J
12/4-5/00	4	1U	110	1U	43	9	260	14	260	160	600	46	320	180	36	23	17	14	870J	430	4	410	33	57	8
12/18-19/00	1U	1U	5	1U	**	6	43	23	77	60	34	2100J	230	**	35	12	26	20	**	74	5	140	27	96	55
1/2-3/01	72	87	68	82	96	9	48	59	160	350	92	2600	130	190	43	4	12	42	540	650J	17	460	2	540	200
1/15-16/01	3	1U	71	1U	32	200J	79	240	87	100	65	210	77	96	360	4	23	26	380	280	2	200	7	670	54
1/22-23/01	9	3	18	1	31	14	59	8	33	26	74	150	280	120	88	8	31	4	500	770	18	440	7	4600	120
1/29-30/01	11	13	14	24	49	39	72	150	53	92	35	63	20	120	570	120	23	5	180	3000	51	220	10	3300J	2300J
2/13-14/01	100	81	42	150J	13	28	120	45	31	37	10	230	21	100	520	3	23	140	23	770	7	100	6	450	660
2/26-27/01	200	230	120	410	86	140	260	110	270	310	55	31	300J	480J	1600	3	22	63	49	5900J	360J	1300J	5	770	330
3/12-13/01	300	360	520J	420	120	360J	210	47	230	340J	660J	17	54	620J	92	3	100	130	120	1100	3	970J	12	370	410
3/26-27/01	54	92	210	140	80	37	96	48	110	210	310	32	110	110	54	4	76	29	15	230	6	610	61	85	77

* = No analysis - sample lost

** = No sample - stream frozen

U = Analyte not detected at the detection limit shown

J = The number reported is an estimate, although the "true" value may be greater than or equal to the reported value

Bolded = Result exceeds the first criterion of the "initially proposed" Class A water quality standard for enterococcus bacteria (33 cfu/100 mL)

= Result exceeds the second criterion of the "initially proposed" Class A water quality standard for enterococcus bacteria (61 cfu/100 mL)

Table B4. Temperature measurements (^{o}C) for the Colville River Fecal Coliform TMDL Study, March 13, 2000 - March 27, 2001.

DATE	CR 24	CR 23	MILL22	CR 21	CR 20	HAL 19	CR 18	LPOR 17	CR 16	STRN 15	STEN 14	BLU 13	CR 12	CR 11	CHEW 10	SHER 9	COT 8	HUC 7	WLC6A	CR 6	JOJ 5	CR 4	DEC 3	SCH 2	SCH 1
3/13/00	5.2	5.2	6.5	4.4	4.4	2.9	4.7	2.7	4.7	3.3	2.8	3.0	4.5	3.6	3.4	4.4	4.4	2.1	3.3	2.7	3.7	2.7	2.2	3.4	3.5
3/27/00	7.0	7.3	7.4	7.3	7.8	6.3	7.4	6.6	7.8	9.0	6.8	8.0	8.0	7.9	7.1	5.8	6.1	4.8	4.9	5.0	6.0	4.4	3.8	4.9	4.8
4/10/00	7.9	7.9	6.4	8.6	8.5	7.2	8.8	7.2	10.3	10.0	9.8	10.8	10.8	10.2	9.8	6.1	7.3	5.1	8.8	6.9	9.2	6.0	5.4	6.5	6.7
4/24-25/00	8.4	8.1	*	8.6	8.1	6.2	8.0	6.2	8.4	5.4	*	8.6	10.5	17.4	5.8	6.1	7.1	5.5	7.2	6.8	10.2	6.3	5.7	6.7	6.6
5/8-9/00	10.3	10.4	9.3	10.9	10.5	8.7	10.4	9.6	10.2	7.9	8.2	7.5	10.1	7.8	6.4	6.7	7.7	6.0	10.9	7.8	10.7	6.5	5.8	6.2	6.7
5/22-23/00	12.3	12.2	9.0	13.4	13.2	9.2	13.4	12.3	14.4	13.2	14.4	15.2	13.8	13.0	11.5	10.2	13.3	11.8	15.6	12.6	15.9	11.4	9.8	10.7	10.4
6/5-6/00	15.0	14.5	12.5	15.0	14.6	11.1	14.3	12.3	14.1	*	11.8	14.2	14.8	13.2	11.4	10.2	12.2	12.3	17.5	14.2	17.2	12.0	10.2	11.2	11.2
6/19-20/00	15.4	15.4	15.3	15.4	15.3	11.3	14.7	11.2	14.2	11.2	11.5	10.8	15.2	14.1	12.2	11.0	13.5	12.6	16.6	13.3	16.6	12.0	10.5	15.0	14.0
7/17-18/00	16.7	16.7	11.9	17.6	17.5	13.0	17.0	16.2	**18.5**	17.0	**18.2**	16.0	17.8	17.5	14.8	12.1	14.5	14.6	17.9	15.2	**18.5**	13.7	11.3	11.5	11.0
7/31-8/1/00	**22.0**	**21.3**	**18.3**	**21.7**	**21.2**	16.3	**19.5**	17.6	**19.4**	17.1	15.9	16.8	**19.4**	**19.1**	16.8	13.4	14.6	15.4	**19.2**	15.9	**20.7**	15.2	13.4	13.0	12.2
8/14-15/00	18.0	17.3	15.7	17.7	17.2	12.0	15.6	13.4	15.7	12.7	11.8	14.5	15.8	16.0	14.0	10.8	*	12.3	12.6	12.9	16.6	11.8	10.3	10.2	9.6
8/28-29/00	14.6	13.8	12.3	14.2	14.1	9.7	13.0	11.1	13.5	10.5	*	12.4	13.3	13.5	11.7	9.3	10.1	9.2	10.4	10.6	13.7	9.4	7.8	8.2	8.0
9/11-12/00	13.4	12.6	13.5	12.9	12.6	10.2	11.7	10.5	11.7	9.6	9.2	11.1	11.5	12.5	11.5	10.3	11.0	10.5	12.5	11.1	14.0	10.4	9.7	9.7	9.4
9/25-26/00	9.6	9.6	9.3	8.6	8.2	5.8	7.8	6.0	7.9	8.4	9.2	8.7	8.3	8.7	7.8	6.8	6.8	5.4	6.8	7.0	9.0	5.6	5.1	5.2	5.5
10/10-11/00	9.7	9.4	10.5	9.3	8.7	7.4	8.0	6.9	8.0	7.2	6.7	8.4	7.6	8.1	7.8	*	7.1	5.7	5.7	7.0	8.4	6.1	5.7	6.0	6.4
10/23-24/00	4.8	4.6	5.1	4.3	4.2	2.3	4.3	2.3	4.2	4.6	5.3	5.4	5.2	5.4	5.2	4.7	4.3	2.9	6.0	4.5	5.5	5.5	3.1	3.5	4.1
11/6-7/00	3.7	3.6	4.9	3.4	3.3	*	3.0	1.7	3.3	1.6	*	4.3	4.3	4.3	*	4.0	3.5	2.1	2.7	3.7	3.3	2.8	3.0	3.2	3.7
12/4-5/00	2.2	2.3	4.2	2.2	2.1	1.1	1.7	1.2	2.0	0.8	0.6	2.1	*	3.2	*	2.9	3.6	1.8	1.5	3.4	2.1	2.3	2.4	3.2	1.7
12/18-19/00	-0.2	**	0.4	-0.2	**	-0.2	**	-0.2	-0.2	-0.2	-0.2	-0.2	-0.2	**	0.4	0.4	0.4	-0.2	**	-0.2	-0.2	-0.2	-0.2	-0.2	-0.2
1/2-3/01	0.6	0.6	3.2	0.9	0.8	0.7	0.5	0.1	1.0	0.1	0.1	1.5	2.4	2.5	2.6	3.0	3.3	0.9	0.5	2.6	1.3	1.8	2.0	2.4	3.0
1/15-16/01	-0.2	-0.2	-0.2	-0.2	-0.2	-0.2	-0.2	-0.2	-0.2	-0.2	-0.2	**	0.7	1.0	0.7	0.2	0.6	-0.2	-0.2	1.7	0.3	1.0	0.9	1.7	2.1
1/22-23/01	1.4	1.5	3.6	1.3	1.0	-0.1	0.6	-0.1	1.0	0.2	0.0	1.6	2.0	2.7	3.3	3.4	2.7	1.3	1.7	3.0	2.3	2.0	2.3	2.6	3.0
1/29-30/01	0.2	0.1	2.0	0.1	0.2	-0.2	0.0	*	0.3	-0.2	-0.2	1.0	1.5	1.8	2.0	2.3	2.4	0.3	0.0	1.9	1.1	1.0	1.0	1.3	2.0
2/13-14/01	0.5	0.3	2.5	0.0	-0.1	-0.2	**	0.0	-0.2	-0.2	-0.2	0.0	0.4	2.0	2.4	2.3	3.7	0.1	0.4	2.2	1.5	0.6	0.9	0.7	1.3
2/26-27/01	1.4	1.6	0.9	0.7	0.5	-0.1	0.3	-0.3	0.3	-0.2	-0.2	0.1	1.5	1.5	1.8	0.6	1.2	-0.1	-0.1	0.9	-0.2	-0.2	-0.2	-0.3	0.4
3/12-13/01	6.5	6.0	7.4	5.5	5.4	3.0	5.2	3.5	5.0	2.7	2.3	5.1	3.4	3.7	4.8	3.7	3.5	1.8	1.4	3.0	2.7	2.7	2.4	3.3	3.7
3/26-27/01	6.1	5.9	5.9	5.8	5.6	3.0	5.7	2.5	3.7	3.6	3.7	8.5	7.0	6.7	6.2	6.5	6.0	3.8	4.2	5.4	5.8	3.4	3.0	5.4	5.7

* = Measurement not taken or recorded

** = Stream frozen - no measurement

Bolded = Result is greater than the Class A water quality standard for temperature (18 ^{o}C)

Table B5. Colville River fecal coliform TMDL synoptic survey of July 25-26, 2000.

Date	Site	Total Alkalinity (mg/L)	Conductance (*u* mhos/cm)	Chlorophyll *a* (*u* g/L)	BOD5 (mg/L)	TPN (mg/L)	NO_2-NO_3 (mg/L)	NO_2 (mg/L)	NH_3 (mg/L)	TP (mg/L)	OPO_4 (mg/L)	TOC (mg/L)
7/26/00	CR 24	172	350	16.6	2U	0.295	0.146	0.010U	0.010U	0.060	0.016	2.4
7/26/00	CR 23	171	349	9.1		0.318	0.164	0.010U	0.010U	0.055	0.020	2.3
7/26/00	MILL 22	212	444	1.9		0.558	0.488	0.010U	0.010U	0.017	0.006	1.1
7/26/00	CR 21	162	331	9.2		0.305	0.106	0.010U	0.036	0.071	0.031	2.5
7/26/00	CR 20	159	318	8.9	2U	0.238	0.096	0.010U	0.010U	0.053	0.016	2.5
7/26/00	HAL 19	184	377	1.2		0.246	0.124	0.010U	0.010U	0.066	0.045	3.0
7/26/00	CR 18	156	311	5.1		0.266	0.127	0.010U	0.010U	0.057	0.016	2.4
7/26/00	LPOR 17	5U	194	1.3		0.134	0.022	0.010U	0.010U	0.030	0.013	3.0
7/25/00	CR 16	94.7	337	5.0		0.336	0.174	0.010U	0.010U	0.047	0.025	2.3
7/25/00	STRN 15	247	480	3.1		0.447	0.113	0.010U	0.010U	0.059	0.031	3.1
7/25/00	STEN 14	222	420	2.8		0.351	0.166	0.010U	0.011	0.070	0.054	3.0
7/25/00	BLU 13	234	445	2.3		0.194	0.085	0.010U	0.010U	0.048	0.041	2.2
7/25/00	CR 12	171	335	3.5		0.384	0.234	0.010U	0.019	0.051	0.022	2.0
7/25/00	CR 11	164	325	2.8	2U	0.400	0.254	0.010U	0.010U	0.036	0.015	1.9
7/25/00	CHEW 10	111	235	2.1		0.557	0.438	0.010U	0.010U	0.041	0.022	2.2
7/25/00	SHER 9	161	317	0.81		0.135	0.093	0.010U	0.010U	0.028	0.017	1.1
7/25/00	COT 8	195	376	1.8		0.430	0.304	0.010U	0.010U	0.024	0.010	2.0
7/25/00	HUC 7	170	334	2.3		0.251	0.154	0.010U	0.010U	0.030	0.014	1.8
7/25/00	WLC6A	154	296	1.1		0.286	0.035	0.010U	0.010U	0.020	0.010	4.3
7/25/00	CR 6	187	355	2.0		0.397	0.256	0.010U	0.010	0.034	0.017	1.5
7/25/00	JOJ 5	120	232	1.7		0.193	0.015	0.010U	0.010U	0.014	0.008	2.3
7/25/00	CR 4	186	356	3.5	2U	0.415	0.298	0.010U	0.010U	0.044	0.022	1.7
7/25/00	DEC 3	148	290	1.1		0.710	0.600	0.010U	0.010U	0.028	0.017	1.3
7/25/00	SCH 2	185	354	1.8		0.335	0.260	0.010U	0.010U	0.026	0.016	1.1
7/25/00	SCH 1	177	337	2.3		0.334	0.245	0.010U	0.010U	0.026	0.012	1.1

U = Analyte not found above detection limit shown.

Table B6. Colville River fecal coliform TMDL synoptic survey of September 19-20, 2000.

Date	Site	Total Alkalinity (mg/L)	Conductance (*u* mhos/cm)	Chlorophyll *a* (*u* g/L)	BOD5 (mg/L)	TPN (mg/L)	NO_2-NO_3 (mg/L)	NO_2 (mg/L)	NH_3 (mg/L)	TP (mg/L)	OPO_4 (mg/L)	TOC (mg/L)
9/20/00	CR 24	183	376	8.9	2U	0.368	0.281	0.010UJ	0.010U	0.064	0.027	2.4
9/20/00	CR 23	182	373	8.6J		0.380	0.299	0.010UJ	0.010U	0.068	0.032	2.3
9/20/00	MILL 22	219	468	1.8J		0.682	0.644	0.010UJ	0.010U	0.025	0.005U	1.2
9/20/00	CR 21	175	356	9.8J		0.353	0.202	0.010UJ	0.020	0.086	0.045	2.6
9/20/00	CR 20	170	341	6.4J	2U	0.293	0.190	0.010UJ	0.010U	0.074	0.025	2.4
9/20/00	HAL 19	204	425	0.57J		0.149	0.071	0.010UJ	0.010U	0.071	0.039	3.1
9/20/00	CR 18	170	337	4.7J		0.338	0.206	0.010UJ	0.019	0.092	0.030	2.5
9/20/00	LPOR 17	110	225	2.4J		0.091	0.010U	0.010UJ	0.010U	0.037	0.008	3.0
9/19/00	CR 16	184	359	2.8		0.404	0.274	0.010UJ	0.037	0.087	0.037	2.2
9/19/00	STRN 15	242	492	1.6		0.187	0.090	0.010UJ	0.010U	0.058	0.026	3.2
9/19/00	STEN 14	213	406	2.1		0.192	0.057	0.010UJ	0.010U	0.064	0.035	3.3
9/19/00	BLU 13	239	454	2.0		0.158	0.079	0.010UJ	0.010U	0.059	0.028	2.5
9/19/00	CR 12	181	353	1.9		0.429	0.314	0.010UJ	0.030	0.075	0.037	2.1
9/19/00	CR 11	178	346	1.4	2U	0.411	0.323	0.010UJ	0.013	0.050	0.018	2.0
9/19/00	CHEW 10	127	264	1.3		0.601	0.549	0.010UJ	0.010U	0.056	0.025	2.4
9/19/00	SHER 9	186	359	0.73		0.116	0.087	0.010UJ	0.010U	0.037	0.015	1.5
9/19/00	COT 8	210	400	1.4		0.349	0.293	0.010UJ	0.010U	0.033	0.008	1.6
9/19/00	HUC 7	186	362	4.3		0.210	0.148	0.010UJ	0.010U	0.033	0.008	2.0
9/19/00	WLC6A	154	301	4.6J		0.214	0.010U	0.010UJ	0.010U	0.023	0.006	4.8
9/19/00	CR 6	190	364	2.0J		0.388	0.285	0.010UJ	0.010U	0.055	0.018	2.0
9/19/00	JOJ 5	132	255	2.0J		0.165	0.024	0.010UJ	0.010U	0.075	0.005U	2.5
9/19/00	CR 4	190	365	2.3J	2U	0.344	0.301	0.010UJ	0.010U	0.060	0.021	1.9
9/19/00	DEC 3	152	300	1.2J		0.560	0.557	0.010UJ	0.010U	0.040	0.014	1.3
9/19/00	SCH 2	187	358	1.2J		0.325	0.287	0.010UJ	0.010U	0.033	0.016	1.3
9/19/00	SCH 1	177	343	1.3J		0.308	0.304	0.010UJ	0.010U	0.034	0.012	1.3

U = Analyte not found above detection limit shown.

J = Results are estimates due to analyses performed beyond 24 hour holding time for NO_2 and filtered beyond 24 hour holding for chlorophyll.

Table B7. Sample day discharge (cfs) for the Colville River fecal coliform TMDL monitoring stations.

SCH 1		**SCH 2**		**DEC 3**		**CR 4**		**JOJ 5**		**CR 6**		**WLC 6A**	
Date	Q	Date	Q	Date	Q	Date	Q	Date	Q	Date	Q	Date	Q
13-Mar-00	47.6	13-Mar-00	52.9	13-Mar-00	34.8	13-Mar-00	104	13-Mar-00	15.1	13-Mar-00	142	13-Mar-00	10.4
27-Mar-00	42.0	27-Mar-00	46.7	27-Mar-00	30.7	27-Mar-00	92.1	27-Mar-00	13.3	27-Mar-00	125	27-Mar-00	9.15
10-Apr-00	58.7	10-Apr-00	65.2	10-Apr-00	42.9	10-Apr-00	129	10-Apr-00	18.6	10-Apr-00	174	10-Apr-00	12.8
24-Apr-00	86.2	24-Apr-00	95.8	24-Apr-00	63.0	24-Apr-00	189	24-Apr-00	27.4	24-Apr-00	256	24-Apr-00	18.8
8-May-00	57.1	8-May-00	63.5	8-May-00	41.7	8-May-00	125	8-May-00	18.1	8-May-00	170	8-May-00	12.4
22-May-00	38.8	22-May-00	43.1	22-May-00	28.3	22-May-00	85.0	22-May-00	12.3	22-May-00	115	22-May-00	8.45
5-Jun-00	24.1	5-Jun-00	26.7	5-Jun-00	17.6	5-Jun-00	52.7	5-Jun-00	7.63	5-Jun-00	71.5	5-Jun-00	5.24
19-Jun-00	23.4	19-Jun-00	26.0	19-Jun-00	17.1	19-Jun-00	51.3	19-Jun-00	7.43	19-Jun-00	69.6	19-Jun-00	5.10
17-Jul-00	11.7	17-Jul-00	13.0	17-Jul-00	8.54	17-Jul-00	25.6	17-Jul-00	3.71	17-Jul-00	34.7	17-Jul-00	2.54
31-Jul-00	7.72	31-Jul-00	8.58	31-Jul-00	5.64	31-Jul-00	16.9	31-Jul-00	2.45	31-Jul-00	22.9	31-Jul-00	1.68
14-Aug-00	5.87	14-Aug-00	6.52	14-Aug-00	4.29	14-Aug-00	12.9	14-Aug-00	1.86	14-Aug-00	17.4	14-Aug-00	1.28
28-Aug-00	5.66	28-Aug-00	6.29	28-Aug-00	4.13	28-Aug-00	12.4	28-Aug-00	1.80	28-Aug-00	16.8	28-Aug-00	1.23
11-Sep-00	10.2	11-Sep-00	11.3	11-Sep-00	7.42	11-Sep-00	22.2	11-Sep-00	3.22	11-Sep-00	30.2	11-Sep-00	2.21
25-Sep-00	9.41	25-Sep-00	10.5	25-Sep-00	6.87	25-Sep-00	20.6	25-Sep-00	2.99	25-Sep-00	28.0	25-Sep-00	2.05
10-Oct-00	8.04	10-Oct-00	8.93	10-Oct-00	5.87	10-Oct-00	17.6	10-Oct-00	2.55	10-Oct-00	23.9	10-Oct-00	1.75
23-Oct-00	10.3	23-Oct-00	11.4	23-Oct-00	7.49	23-Oct-00	22.5	23-Oct-00	3.26	23-Oct-00	30.5	23-Oct-00	2.23
6-Nov-00	10.8	6-Nov-00	12.0	6-Nov-00	7.88	6-Nov-00	23.6	6-Nov-00	3.42	6-Nov-00	32.1	6-Nov-00	2.35
4-Dec-00	9.52	4-Dec-00	10.6	4-Dec-00	6.95	4-Dec-00	20.8	4-Dec-00	3.02	4-Dec-00	28.3	4-Dec-00	2.07
18-Dec-00	9.68	18-Dec-00	10.8	18-Dec-00	7.07	18-Dec-00	21.2	18-Dec-00	3.07	18-Dec-00	28.8	18-Dec-01	2.11
2-Jan-01	10.2	2-Jan-01	11.3	2-Jan-01	7.42	2-Jan-01	22.2	2-Jan-01	3.22	2-Jan-01	30.2	2-Jan-01	2.21
15-Jan-01	8.88	15-Jan-01	9.87	15-Jan-01	6.49	15-Jan-01	19.5	15-Jan-01	2.82	15-Jan-01	26.4	15-Jan-01	1.93
22-Jan-01	10.3	22-Jan-01	11.4	22-Jan-01	7.49	22-Jan-01	22.5	22-Jan-01	3.26	22-Jan-01	30.5	22-Jan-01	2.23
29-Jan-01	10.2	29-Jan-01	11.3	29-Jan-01	7.45	29-Jan-01	22.3	29-Jan-01	3.24	29-Jan-01	30.3	29-Jan-01	2.22
13-Feb-01	8.35	13-Feb-01	9.28	13-Feb-01	6.10	13-Feb-01	18.3	13-Feb-01	2.65	13-Feb-01	24.8	13-Feb-01	1.82
26-Feb-01	9.62	26-Feb-01	10.7	26-Feb-01	7.03	26-Feb-01	21.1	26-Feb-01	3.05	26-Feb-01	28.6	26-Feb-01	2.09
12-Mar-01	15.2	12-Mar-01	16.9	12-Mar-01	11.1	12-Mar-01	33.2	12-Mar-01	4.82	12-Mar-01	45.1	12-Mar-01	3.30
26-Mar-01	24.2	26-Mar-01	26.8	26-Mar-01	17.6	26-Mar-01	52.9	26-Mar-01	7.67	26-Mar-01	71.8	26-Mar-01	5.26

Table B7 con't. Sample day discharge (cfs) for the Colville River fecal coliform TMDL monitoring stations.

HUC 7		COT 8		SHER 9		CHEW 10		CR 11		CR 12	
Date	Q	Date	Q	Date	Q	Date	Q	Date	Q	Date	Q
13-Mar-00	34.1	13-Mar-00	36.8	13-Mar-00	10.9	13-Mar-00	105	13-Mar-00	346	13-Mar-00	334
27-Mar-00	30.1	27-Mar-00	32.4	27-Mar-00	9.64	27-Mar-00	92.5	27-Mar-00	306	27-Mar-00	299
10-Apr-00	42.0	10-Apr-00	45.3	10-Apr-00	13.5	10-Apr-00	130	10-Apr-00	427	10-Apr-00	402
24-Apr-00	61.6	24-Apr-00	66.5	24-Apr-00	19.8	24-Apr-00	191	24-Apr-00	627	24-Apr-00	573
8-May-00	40.8	8-May-00	44.1	8-May-00	13.1	8-May-00	126	8-May-00	415	8-May-00	392
22-May-00	27.8	22-May-00	29.9	22-May-00	8.90	22-May-00	92.5	22-May-00	282	22-May-00	279
5-Jun-00	17.2	5-Jun-00	18.6	5-Jun-00	5.52	5-Jun-00	61.9	5-Jun-00	175	5-Jun-00	210
19-Jun-00	16.7	19-Jun-00	18.1	19-Jun-00	5.37	19-Jun-00	58.7	19-Jun-00	170	19-Jun-00	202
17-Jul-00	8.36	17-Jul-00	9.01	17-Jul-00	2.68	17-Jul-00	28.0	17-Jul-00	85.0	17-Jul-00	113
31-Jul-00	5.52	31-Jul-00	5.96	31-Jul-00	1.77	31-Jul-00	18.5	31-Jul-00	56.1	31-Jul-00	78.7
14-Aug-00	4.20	14-Aug-00	4.53	14-Aug-00	1.35	14-Aug-00	12.1	14-Aug-00	42.7	14-Aug-00	56.1
28-Aug-00	4.05	28-Aug-00	4.36	28-Aug-00	1.30	28-Aug-00	11.5	28-Aug-00	41.1	28-Aug-00	61.4
11-Sep-00	7.26	11-Sep-00	7.83	11-Sep-00	2.33	11-Sep-00	21.0	11-Sep-00	73.8	11-Sep-00	108
25-Sep-00	6.73	25-Sep-00	7.26	25-Sep-00	2.16	25-Sep-00	15.9	25-Sep-00	68.4	25-Sep-00	92.1
10-Oct-00	5.75	10-Oct-00	6.20	10-Oct-00	1.84	10-Oct-00	14.6	10-Oct-00	58.4	10-Oct-00	92.1
23-Oct-00	7.34	23-Oct-00	7.91	23-Oct-00	2.35	23-Oct-00	22.3	23-Oct-00	74.6	23-Oct-00	108
6-Nov-00	7.71	6-Nov-00	8.32	6-Nov-00	2.47	6-Nov-00	26.1	6-Nov-00	78.4	6-Nov-00	114
4-Dec-00	6.81	4-Dec-00	7.34	4-Dec-00	2.18	4-Dec-00	19.8	4-Dec-00	69.2	4-Dec-00	105
18-Dec-00	6.92	18-Dec-00	7.46	18-Dec-00	2.22	18-Dec-00	15.3	18-Dec-01	70.4	18-Dec-00	82.1
2-Jan-01	7.26	2-Jan-01	7.83	2-Jan-01	2.33	2-Jan-01	17.8	2-Jan-01	73.8	2-Jan-01	95.3
15-Jan-01	6.35	15-Jan-01	6.85	15-Jan-01	2.04	15-Jan-01	16.0	15-Jan-01	64.6	15-Jan-01	92.1
22-Jan-01	7.34	22-Jan-01	7.91	22-Jan-01	2.35	22-Jan-01	21.0	22-Jan-01	74.6	22-Jan-01	87.1
29-Jan-01	7.30	29-Jan-01	7.87	29-Jan-01	2.34	29-Jan-01	19.1	29-Jan-01	74.2	29-Jan-01	83.8
13-Feb-01	5.97	13-Feb-01	6.44	13-Feb-01	1.92	13-Feb-01	19.1	13-Feb-01	60.8	13-Feb-01	82.1
26-Feb-01	6.88	26-Feb-01	7.42	26-Feb-01	2.21	26-Feb-01	14.0	26-Feb-01	70.0	26-Feb-01	92.1
12-Mar-01	10.9	12-Mar-01	11.7	12-Mar-01	3.48	12-Mar-01	23.6	12-Mar-01	110	12-Mar-01	147
26-Mar-01	17.3	26-Mar-01	18.6	26-Mar-01	5.54	26-Mar-01	42.1	26-Mar-01	176	26-Mar-01	175

Table B7 con't. Sample day discharge (cfs) for the Colville River fecal coliform TMDL monitoring stations.

BLU 13		STEN 14		STRN 15		CR 16		LOPR 17		CR 18	
Date	Q	Date	Q	Date	Q	Date	Q	Date	Q	Date	Q
13-Mar-00	12.8	13-Mar-00	31.3	13-Mar-00	22.5	13-Mar-00	466	13-Mar-00	210	13-Mar-00	683
27-Mar-00	11.3	27-Mar-00	27.2	27-Mar-00	19.5	27-Mar-00	411	27-Mar-00	179	27-Mar-00	602
10-Apr-00	15.8	10-Apr-00	40.0	10-Apr-00	28.7	10-Apr-00	574	10-Apr-00	272	10-Apr-00	841
24-Apr-00	23.2	25-Apr-00	58.8	25-Apr-00	42.2	25-Apr-00	796	25-Apr-00	408	25-Apr-00	1170
8-May-00	15.4	9-May-00	35.7	9-May-00	25.6	9-May-00	522	9-May-00	242	9-May-00	765
22-May-00	10.5	23-May-00	23.6	23-May-00	16.9	23-May-00	361	23-May-00	168	23-May-00	530
5-Jun-00	6.48	6-Jun-00	16.8	6-Jun-00	12.1	6-Jun-00	226	6-Jun-00	87.2	6-Jun-00	332
20-Jun-00	6.31	20-Jun-00	12.4	20-Jun-00	8.90	20-Jun-00	218	20-Jun-00	83.8	20-Jun-00	320
18-Jul-00	3.02	18-Jul-00	5.96	18-Jul-00	4.28	18-Jul-00	110	18-Jul-00	40.0	18-Jul-00	161
31-Jul-00	2.08	1-Aug-00	3.27	1-Aug-00	2.35	1-Aug-00	71.8	1-Aug-00	25.4	1-Aug-00	105
14-Aug-00	1.58	15-Aug-00	2.38	15-Aug-00	1.71	15-Aug-00	56.9	15-Aug-00	19.8	15-Aug-00	83.4
28-Aug-00	1.52	29-Aug-00	2.56	29-Aug-00	1.84	29-Aug-00	55.3	29-Aug-00	19.2	29-Aug-00	81.1
11-Sep-00	2.73	12-Sep-00	4.14	12-Sep-00	2.97	12-Sep-00	94.1	12-Sep-00	33.9	12-Sep-00	138
25-Sep-00	2.53	25-Sep-00	4.14	25-Sep-00	2.97	26-Sep-00	81.2	26-Sep-00	29.0	26-Sep-00	119
10-Oct-00	2.16	11-Oct-00	4.65	11-Oct-00	3.34	11-Oct-00	77.5	11-Oct-00	27.6	11-Oct-00	114
23-Oct-00	2.76	23-Oct-00	6.12	23-Oct-00	4.39	24-Oct-00	94.6	24-Oct-00	34.1	24-Oct-00	139
6-Nov-00	2.90	7-Nov-00	7.22	7-Nov-00	5.18	7-Nov-00	97.2	7-Nov-00	35.1	7-Nov-00	142
4-Dec-00	2.56	5-Dec-00	7.37	5-Dec-00	5.29	5-Dec-00	91.0	5-Dec-00	32.7	5-Dec-00	133
18-Dec-00	2.61	19-Dec-00	8.50	19-Dec-00	6.10	19-Dec-00	101	19-Dec-00	36.8	19-Dec-00	149
2-Jan-01	2.73	3-Jan-01	8.11	3-Jan-01	5.82	3-Jan-01	97.2	3-Jan-01	35.1	3-Jan-01	142
15-Jan-01	2.39	16-Jan-01	4.39	16-Jan-01	3.15	16-Jan-01	54.8	16-Jan-01	19.0	16-Jan-01	80.3
22-Jan-01	2.76	23-Jan-01	8.15	23-Jan-01	5.85	23-Jan-01	97.7	23-Jan-01	35.3	23-Jan-01	143
29-Jan-01	2.75	30-Jan-01	7.88	30-Jan-01	5.66	30-Jan-01	94.6	30-Jan-01	34.1	30-Jan-01	139
13-Feb-01	2.25	14-Feb-01	8.25	14-Feb-01	5.92	14-Feb-01	98.7	14-Feb-01	35.7	14-Feb-01	145
26-Feb-01	2.59	27-Feb-01	7.14	27-Feb-01	5.13	27-Feb-01	86.3	27-Feb-01	30.9	27-Feb-01	127
12-Mar-01	4.09	13-Mar-01	14.0	13-Mar-01	10.1	13-Mar-01	161	13-Mar-01	60.6	13-Mar-01	236
26-Mar-01	6.51	27-Mar-01	22.4	27-Mar-01	16.1	27-Mar-01	250	27-Mar-01	96.8	27-Mar-01	366

Table B7 con't. Sample day discharge (cfs) for the Colville River fecal coliform TMDL monitoring stations.

HAL 19		CR 20		CR 21		Mill 22		CR 23		CR 24	
Date	Q	Date	Q	Date	Q	Date	Q	Date	Q	Date	Q
13-Mar-00	30.5	13-Mar-00	721	13-Mar-00	731	13-Mar-00	196	13-Mar-00	877	13-Mar-00	887
27-Mar-00	26.9	27-Mar-00	636	27-Mar-00	645	27-Mar-00	169	27-Mar-00	774	27-Mar-00	783
10-Apr-00	37.5	10-Apr-00	888	10-Apr-00	901	10-Apr-00	252	10-Apr-00	1080	10-Apr-00	1090
25-Apr-00	52.1	25-Apr-00	1230	25-Apr-00	1250	25-Apr-00	372	25-Apr-00	1500	25-Apr-00	1520
9-May-00	34.1	9-May-00	808	9-May-00	820	9-May-00	225	9-May-00	984	9-May-00	994
23-May-00	23.6	23-May-00	559	23-May-00	567	23-May-00	167	23-May-00	681	23-May-00	688
6-Jun-00	14.8	6-Jun-00	350	6-Jun-00	356	6-Jun-00	94.0	6-Jun-00	427	6-Jun-00	431
20-Jun-00	14.3	20-Jun-00	337	20-Jun-00	343	20-Jun-00	75.3	20-Jun-00	411	20-Jun-00	415
18-Jul-00	7.17	18-Jul-00	170	18-Jul-00	172	18-Jul-00	32.1	18-Jul-00	206	18-Jul-00	209
1-Aug-00	4.70	1-Aug-00	111	1-Aug-00	113	1-Aug-00	22.1	1-Aug-00	135	1-Aug-00	137
15-Aug-00	3.72	15-Aug-00	88.0	15-Aug-00	89.3	15-Aug-00	17.7	15-Aug-00	107	15-Aug-00	108
29-Aug-00	3.62	29-Aug-00	85.6	29-Aug-00	86.9	29-Aug-00	17.7	29-Aug-00	104	29-Aug-00	105
12-Sep-00	6.15	12-Sep-00	146	12-Sep-00	148	12-Sep-00	24.9	12-Sep-00	177	12-Sep-00	179
26-Sep-00	5.31	26-Sep-00	126	26-Sep-00	127	26-Sep-00	22.1	26-Sep-00	153	26-Sep-00	155
11-Oct-00	5.07	11-Oct-00	120	11-Oct-00	122	11-Oct-00	24.9	11-Oct-00	146	11-Oct-00	148
24-Oct-00	6.19	24-Oct-00	146	24-Oct-00	149	24-Oct-00	29.3	24-Oct-00	178	24-Oct-00	180
7-Nov-00	6.35	7-Nov-00	150	7-Nov-00	153	7-Nov-00	27.8	7-Nov-00	183	7-Nov-00	185
5-Dec-00	5.95	5-Dec-00	141	5-Dec-00	143	5-Dec-00	24.9	5-Dec-00	171	5-Dec-00	173
19-Dec-00	6.62	19-Dec-01	157	19-Dec-00	159	19-Dec-00	29.7	19-Dec-00	191	19-Dec-00	193
3-Jan-01	6.35	3-Jan-01	150	3-Jan-01	153	3-Jan-01	28.5	3-Jan-01	183	3-Jan-01	185
16-Jan-01	3.58	16-Jan-01	84.8	16-Jan-01	86.0	16-Jan-01	16.1	16-Jan-01	103	16-Jan-01	104
23-Jan-01	6.39	23-Jan-01	151	23-Jan-01	153	23-Jan-01	28.6	23-Jan-01	184	23-Jan-01	186
30-Jan-01	6.19	30-Jan-01	146	30-Jan-01	149	30-Jan-01	27.7	30-Jan-01	178	30-Jan-01	180
14-Feb-01	6.46	14-Feb-01	153	14-Feb-01	155	14-Feb-01	28.9	14-Feb-01	186	14-Feb-01	188
27-Feb-01	5.64	27-Feb-01	134	27-Feb-01	136	27-Feb-01	25.3	27-Feb-01	163	27-Feb-01	164
13-Mar-01	10.5	13-Mar-01	250	13-Mar-01	253	13-Mar-01	47.2	13-Mar-01	304	13-Mar-01	307
27-Mar-01	16.3	27-Mar-01	386	27-Mar-01	392	27-Mar-01	73.1	27-Mar-01	470	27-Mar-01	476

Table B8. Running geometric means and 90th percentiles for Colville River at Greenwood Loop Road (CR24).

Period:	1 Month			2 Month			3 Month			Total Survey	
	G.M.	90TH		G.M.	90TH		G.M.	90TH		G.M.	90TH
Mar-00	6	6	Mar-Apr	13	47	Mar-Apr-May	17	60	Mar 00-Mar 01	22	136
Apr-00	30	50	Apr-May	30	59	Apr-May-Jun	41	90			
May-00	30	86	May-Jun	47	117	May-Jun-Jul	52	115			
Jun-00	73	102	Jun-Jul	68	106	Jun-Jul-Aug	75	111			
Jul-00	64	124	Jul-Aug	76	122	Jul-Aug-Sep	**82**	146			
Aug-00	90	109	Aug-Sep	**93**	161	Aug-Sep-Oct	44	**205**			
Sep-00	**95**	243	Sep-Oct	31	**179**	Sep-Oct-Nov	18	159			
Oct-00	10	10	Oct-Nov	6	19	Oct-Nov-Dec	6	47			
Nov-00	-	-	Nov-Dec	5	73	Nov-Dec-Jan	6	65			
Dec-00	7	**273**	Dec-Jan	8	89	Dec-Jan-Feb	10	89			
Jan-01	8	84	Jan-Feb	11	98	Jan-Feb-Mar	15	100			
Feb-01	22	53	Feb-Mar	27	89						
Mar-01	33	201									
Max. GM	95			93			82				
Max. 90th		273			179			205			
Rollback GM	-			-			-				
Rollback 90th		27			-			3			
Rollback %								**3**			

Table B9. Running geometric means and 90th percentiles for Colville River at Gold Creek Road (CR23).

Period:	1 Month			2 Month			3 Month			Total Survey	
	G.M.	90TH		G.M.	90TH		G.M.	90TH		G.M.	90TH
Mar-00	7	32	Mar-Apr	10	27	Mar-Apr-May	14	58	Mar 00-Mar 01	17	156
Apr-00	14	16	Apr-May	20	74	Apr-May-Jun	28	89			
May-00	30	220	May-Jun	39	133	May-Jun-Jul	59	207			
Jun-00	51	66	Jun-Jul	83	173	Jun-Jul-Aug	103	212			
Jul-00	135	144	Jul-Aug	146	176	Jul-Aug-Sep	**147**	452			
Aug-00	**159**	199	Aug-Sep	**154**	**652**	Aug-Sep-Oct	50	**635**			
Sep-00	150	**1798**	Sep-Oct	28	521	Sep-Oct-Nov	18	306			
Oct-00	5	14	Oct-Nov	4	10	Oct-Nov-Dec	3	7			
Nov-00	-	-	Nov-Dec	2	3	Nov-Dec-Jan	3	19			
Dec-00	2	2	Dec-Jan	3	23	Dec-Jan-Feb	4	29			
Jan-01	4	49	Jan-Feb	6	63	Jan-Feb-Mar	8	63			
Feb-01	10	53	Feb-Mar	17	57						
Mar-01	28	30									
Max. GM	159			154			147				
Max. 90th		1798			652			635			
Rollback GM	38			36			32				
Rollback 90th		89			70			69			
Rollback %					**70**						

Table B10. Running geometric means and 90th percentiles for the Colville River at Oakshot Road (CR21).

Period:	1 Month			2 Month			3 Month			Total Survey	
	G.M.	90TH		G.M.	90TH		G.M.	90TH		G.M.	90TH
Mar-00	7	15	Mar-Apr	12	26	Mar-Apr-May	14	41	Mar 00-Mar 01	17	196
Apr-00	18	28	Apr-May	19	54	Apr-May-Jun	32	116			
May-00	21	114	May-Jun	42	185	May-Jun-Jul	62	251			
Jun-00	87	133	Jun-Jul	107	185	Jun-Jul-Aug	**120**	216			
Jul-00	132	255	Jul-Aug	**140**	**255**	Jul-Aug-Sep	113	237			
Aug-00	**149**	**328**	Aug-Sep	105	246	Aug-Sep-Oct	25	**473**			
Sep-00	74	177	Sep-Oct	10	205	Sep-Oct-Nov	6	119			
Oct-00	1	3	Oct-Nov	1	2	Oct-Nov-Dec	1	2			
Nov-00	-	-	Nov-Dec	1	1	Nov-Dec-Jan	3	24			
Dec-00	1	1	Dec-Jan	3	33	Dec-Jan-Feb	6	89			
Jan-01	5	81	Jan-Feb	11	139	Jan-Feb-Mar	16	196			
Feb-01	56	74	Feb-Mar	52	136						
Mar-01	49	248									
Max. GM	149			140			120				
Max. 90th		328			255			473			
Rollback GM	33			29			17				
Rollback 90th		40			22			58			
Rollback %								**58**			

Table B11. Running geometric means and 90th percentiles for Colville River at Mantz-Rickey Road (CR20).

Period:	1 Month			2 Month			3 Month			Total Survey	
	G.M.	90TH		G.M.	90TH		G.M.	90TH		G.M.	90TH
Mar-00	5	6	Mar-Apr	10	25	Mar-Apr-May	16	55	Mar 00-Mar 01	23	171
Apr-00	18	26	Apr-May	28	60	Apr-May-Jun	37	85			
May-00	43	81	May-Jun	52	92	May-Jun-Jul	86	266			
Jun-00	64	110	Jun-Jul	123	**362**	Jun-Jul-Aug	143	**356**			
Jul-00	**237**	**432**	Jul-Aug	**214**	340	Jul-Aug-Sep	**168**	307			
Aug-00	194	308	Aug-Sep	141	243	Aug-Sep-Oct	94	274			
Sep-00	103	116	Sep-Oct	66	176	Sep-Oct-Nov	50	161			
Oct-00	42	148	Oct-Nov	30	95	Oct-Nov-Dec	18	91			
Nov-00	-	-	Nov-Dec	8	28	Nov-Dec-Jan	4	21			
Dec-00	-	-	Dec-Jan	3	15	Dec-Jan-Feb	4	19			
Jan-01	3	18	Jan-Feb	5	21	Jan-Feb-Mar	6	24			
Feb-01	10	10	Feb-Mar	10	15						
Mar-01	11	19									
Max. GM	237			214			168				
Max. 90th		432			362			356			
Rollback GM	58			54			41				
Rollback 90th		54			45			44			
Rollback %				**54**							

Table B12. Running geometric means and 90th percentiles for Colville River at Arden Hill Road (CR18).

Period:	1 Month			2 Month			3 Month			Total Survey	
	G.M.	90TH		G.M.	90TH		G.M.	90TH		G.M.	90TH
Mar-00	6	6	Mar-Apr	14	49	Mar-Apr-May	20	69	Mar 00-Mar 01	28	173
Apr-00	32	45	Apr-May	36	62	Apr-May-Jun	45	96			
May-00	39	93	May-Jun	53	126	May-Jun-Jul	91	330			
Jun-00	72	182	Jun-Jul	139	**441**	Jun-Jul-Aug	138	337			
Jul-00	**268**	457	Jul-Aug	**190**	345	Jul-Aug-Sep	**146**	**453**			
Aug-00	135	144	Aug-Sep	108	357	Aug-Sep-Oct	76	245			
Sep-00	87	**634**	Sep-Oct	57	213	Sep-Oct-Nov	49	166			
Oct-00	37	51	Oct-Nov	33	46	Oct-Nov-Dec	27	87			
Nov-00	-	-	Nov-Dec	22	104	Nov-Dec-Jan	9	64			
Dec-00	20	175	Dec-Jan	8	57	Dec-Jan-Feb	8	47			
Jan-01	5	32	Jan-Feb	6	34	Jan-Feb-Mar	8	36			
Feb-01	11	15	Feb-Mar	14	22						
Mar-01	18	21									
Max. GM	268			190			146				
Max. 90th		634			441			453			
Rollback GM	63			48			32				
Rollback 90th		69			55			56			
Rollback %								**56**			

Table B13. Running geometric means and 90th percentiles for Colville River at 12 Mile Road (CR16).

Period:	1 Month			2 Month			3 Month			Total Survey	
	G.M.	90TH		G.M.	90TH		G.M.	90TH		G.M.	90TH
Mar-00	8	8	Mar-Apr	14	33	Mar-Apr-May	24	85	Mar 00-Mar 01	34	203
Apr-00	25	27	Apr-May	40	99	Apr-May-Jun	56	156			
May-00	65	168	May-Jun	84	189	May-Jun-Jul	112	263			
Jun-00	108	245	Jun-Jul	147	284	Jun-Jul-Aug	**149**	253			
Jul-00	**199**	239	Jul-Aug	**174**	231	Jul-Aug-Sep	147	**397**			
Aug-00	153	205	Aug-Sep	126	**427**	Aug-Sep-Oct	91	289			
Sep-00	104	**796**	Sep-Oct	70	264	Sep-Oct-Nov	57	208			
Oct-00	47	67	Oct-Nov	38	66	Oct-Nov-Dec	60	151			
Nov-00	-	-	Nov-Dec	70	239	Nov-Dec-Jan	22	132			
Dec-00	120	180	Dec-Jan	22	154	Dec-Jan-Feb	15	110			
Jan-01	10	33	Jan-Feb	8	31	Jan-Feb-Mar	8	25			
Feb-01	5	31	Feb-Mar	7	21						
Mar-01	9	10									
Max. GM	199			174			149				
Max. 90th		796			427			397			
Rollback GM	50			43			33				
Rollback 90th		75			54			50			
Rollback %					54						

Table B14. Running geometric means and 90th percentiles for Colville River at Bluecreek (CR12).

Period:	1 Month			2 Month			3 Month			Total Survey	
	G.M.	90TH		G.M.	90TH		G.M.	90TH		G.M.	90TH
Mar-00	18	24	Mar-Apr	26	48	Mar-Apr-May	35	105	Mar 00-Mar 01	57	233
Apr-00	38	39	Apr-May	50	148	Apr-May-Jun	78	270			
May-00	64	377	May-Jun	111	**416**	May-Jun-Jul	146	**461**			
Jun-00	194	224	Jun-Jul	**220**	278	Jun-Jul-Aug	197	266			
Jul-00	**248**	309	Jul-Aug	198	290	Jul-Aug-Sep	**199**	349			
Aug-00	159	199	Aug-Sep	178	342	Aug-Sep-Oct	125	297			
Sep-00	199	**583**	Sep-Oct	111	323	Sep-Oct-Nov	84	286			
Oct-00	62	73	Oct-Nov	47	88	Oct-Nov-Dec	59	160			
Nov-00	-	-	Nov-Dec	57	232	Nov-Dec-Jan	38	100			
Dec-00	84	406	Dec-Jan	40	114	Dec-Jan-Feb	36	121			
Jan-01	27	39	Jan-Feb	28	44	Jan-Feb-Mar	23	60			
Feb-01	28	222	Feb-Mar	19	75						
Mar-01	13	24									
Max. GM	248			220			199				
Max. 90th		583			416			461			
Rollback GM	60			55			50				
Rollback 90th		66			52			57			
Rollback %								**57**			

Table B15. Running geometric means and 90th percentiles for Colville River at Alm Lane (CR11).

Period:	1 Month			2 Month			3 Month			Total Survey	
	G.M.	90TH		G.M.	90TH		G.M.	90TH		G.M.	90TH
Mar-00	7	11	Mar-Apr	8	26	Mar-Apr-May	17	92	Mar 00-Mar 01	41	296
Apr-00	11	62	Apr-May	27	163	Apr-May-Jun	46	287			
May-00	68	191	May-Jun	97	253	May-Jun-Jul	130	336			
Jun-00	139	346	Jun-Jul	180	349	Jun-Jul-Aug	185	318			
Jul-00	**234**	284	Jul-Aug	**214**	281	Jul-Aug-Sep	**217**	372			
Aug-00	196	283	Aug-Sep	208	**413**	Aug-Sep-Oct	140	**381**			
Sep-00	222	**675**	Sep-Oct	118	392	Sep-Oct-Nov	87	338			
Oct-00	63	125	Oct-Nov	47	106	Oct-Nov-Dec	46	90			
Nov-00	-	-	Nov-Dec	34	54	Nov-Dec-Jan	38	66			
Dec-00	-	-	Dec-Jan	41	72	Dec-Jan-Feb	16	137			
Jan-01	40	77	Jan-Feb	13	135	Jan-Feb-Mar	16	119			
Feb-01	1	3	Feb-Mar	6	64						
Mar-01	30	47									
Max. GM	234			214			217				
Max. 90th		675			413			381			
Rollback GM	58			54			55				
Rollback 90th		70			52			48			
Rollback %							**55**				

Table B16. Running geometric means and 90th percentiles for Colville River at Waitts Lake Road (CR6).											
Period:	1 Month			2 Month			3 Month			Total Survey	
	G.M.	90TH		G.M.	90TH		G.M.	90TH		G.M.	90TH
Mar-00	5	10	Mar-Apr	11	55	Mar-Apr-May	23	181	Mar 00-Mar 01	91	651
Apr-00	28	91	Apr-May	53	250	Apr-May-Jun	95	514			
May-00	99	612	May-Jun	175	685	May-Jun-Jul	251	**921**			
Jun-00	310	427	Jun-Jul	400	678	Jun-Jul-Aug	419	647			
Jul-00	**516**	**897**	Jul-Aug	**487**	700	Jul-Aug-Sep	**420**	655			
Aug-00	460	594	Aug-Sep	379	565	Aug-Sep-Oct	174	845			
Sep-00	312	467	Sep-Oct	107	536	Sep-Oct-Nov	83	402			
Oct-00	37	51	Oct-Nov	34	45	Oct-Nov-Dec	55	132			
Nov-00	-	-	Nov-Dec	71	200	Nov-Dec-Jan	143	455			
Dec-00	111	169	Dec-Jan	187	413	Dec-Jan-Feb	100	648			
Jan-01	242	507	Jan-Feb	96	**1220**	Jan-Feb-Mar	80	577			
Feb-01	15	172	Feb-Mar	27	159						
Mar-01	47	169									
Max. GM	516			487			420				
Max. 90th		897			1220			921			
Rollback GM	81			80			77				
Rollback 90th		78			84			79			
Rollback %					**84**						

Table B17. Running geometric means and 90th percentiles for Colville River at Betteridge Road (CR4).											
Period:	1 Month			2 Month			3 Month			Total Survey	
	G.M.	90TH		G.M.	90TH		G.M.	90TH		G.M.	90TH
Mar-00	7	29	Mar-Apr	19	121	Mar-Apr-May	35	256	Mar 00-Mar 01	84	692
Apr-00	53	152	Apr-May	80	259	Apr-May-Jun	139	576			
May-00	121	485	May-Jun	224	764	May-Jun-Jul	354	**1390**			
Jun-00	416	540	Jun-Jul	607	1287	Jun-Jul-Aug	**608**	1291			
Jul-00	**885**	**2031**	Jul-Aug	**736**	**1681**	Jul-Aug-Sep	576	1336			
Aug-00	612	1772	Aug-Sep	465	1038	Aug-Sep-Oct	337	830			
Sep-00	353	616	Sep-Oct	250	469	Sep-Oct-Nov	184	518			
Oct-00	177	241	Oct-Nov	119	296	Oct-Nov-Dec	110	218			
Nov-00	-	-	Nov-Dec	80	134	Nov-Dec-Jan	54	96			
Dec-00	98	141	Dec-Jan	54	102	Dec-Jan-Feb	30	153			
Jan-01	40	49	Jan-Feb	20	124	Jan-Feb-Mar	22	86			
Feb-01	5	25	Feb-Mar	12	61						
Mar-01	29	50									
Max. GM	885			736			608				
Max. 90th		2031			1681			1390			
Rollback GM	89			87			84				
Rollback 90th		91			89			86			
Rollback %					**89**						

Table B18. Running geometric means and 90th percentiles for Mill Creek at Highway 395 (MILL22).

Period:	1 Month G.M.	1 Month 90TH		2 Month G.M.	2 Month 90TH		3 Month G.M.	3 Month 90TH		Total Survey G.M.	Total Survey 90TH
Mar-00	5	7	Mar-Apr	12	45	Mar-Apr-May	19	89	Mar 00-Mar 01	38	187
Apr-00	29	29	Apr-May	38	96	Apr-May-Jun	52	151			
May-00	49	212	May-Jun	69	223	May-Jun-Jul	82	216			
Jun-00	96	300	Jun-Jul	105	206	Jun-Jul-Aug	**119**	**236**			
Jul-00	115	124	Jul-Aug	**132**	223	Jul-Aug-Sep	101	210			
Aug-00	**152**	**348**	Aug-Sep	94	**239**	Aug-Sep-Oct	65	184			
Sep-00	59	112	Sep-Oct	42	79	Sep-Oct-Nov	51	111			
Oct-00	31	39	Oct-Nov	47	123	Oct-Nov-Dec	46	92			
Nov-00	-	-	Nov-Dec	61	119	Nov-Dec-Jan	39	215			
Dec-00	46	56	Dec-Jan	33	190	Dec-Jan-Feb	20	135			
Jan-01	28	256	Jan-Feb	15	178	Jan-Feb-Mar	21	150			
Feb-01	5	12	Feb-Mar	16	110						
Mar-01	51	165									
Max. GM	152			132			119				
Max. 90th		348			239			236			
Rollback GM	35			25			16				
Rollback 90th		43			17			16			
Rollback %				**25**							

Table B19. Running geometric means and 90th percentiles for Haller Creek off Skidmore Road (HAL19).

Period:	1 Month G.M.	1 Month 90TH		2 Month G.M.	2 Month 90TH		3 Month G.M.	3 Month 90TH		Total Survey G.M.	Total Survey 90TH
Mar-00	1	3	Mar-Apr	5	30	Mar-Apr-May	7	50	Mar 00-Mar 01	18	201
Apr-00	15	34	Apr-May	17	58	Apr-May-Jun	53	984			
May-00	18	132	May-Jun	98	2917	May-Jun-Jul	137	**2215**			
Jun-00	**539**	**16002**	Jun-Jul	**379**	**3387**	Jun-Jul-Aug	**281**	1698			
Jul-00	266	1127	Jul-Aug	203	514	Jul-Aug-Sep	100	484			
Aug-00	154	184	Aug-Sep	61	241	Aug-Sep-Oct	31	190			
Sep-00	24	27	Sep-Oct	14	43	Sep-Oct-Nov	19	65			
Oct-00	8	31	Oct-Nov	16	85	Oct-Nov-Dec	9	46			
Nov-00	-	-	Nov-Dec	9	77	Nov-Dec-Jan	8	33			
Dec-00	3	9	Dec-Jan	6	15	Dec-Jan-Feb	7	15			
Jan-01	8	17	Jan-Feb	8	15	Jan-Feb-Mar	7	16			
Feb-01	9	15	Feb-Mar	6	16						
Mar-01	4	12									
Max. GM	539			379			281				
Max. 90th		16002			3387			2215			
Rollback GM	82			74			65				
Rollback 90th		99			95			91			
Rollback %					**95**						

Table B20. Running geometric means and 90th percentiles for Little Pend Oreille River at Arden (LPOR17).

Period:	1 Month G.M.	1 Month 90TH		2 Month G.M.	2 Month 90TH		3 Month G.M.	3 Month 90TH		Total Survey G.M.	Total Survey 90TH
Mar-00	3	5	Mar-Apr	3	9	Mar-Apr-May	5	26	Mar 00-Mar 01	18	90
Apr-00	3	19	Apr-May	7	46	Apr-May-Jun	14	93			
May-00	20	26	May-Jun	31	66	May-Jun-Jul	55	198			
Jun-00	49	82	Jun-Jul	92	248	Jun-Jul-Aug	**82**	202			
Jul-00	**171**	**248**	Jul-Aug	**107**	**264**	Jul-Aug-Sep	70	**211**			
Aug-00	66	166	Aug-Sep	45	101	Aug-Sep-Oct	34	81			
Sep-00	30	43	Sep-Oct	25	40	Sep-Oct-Nov	20	43			
Oct-00	20	34	Oct-Nov	15	32	Oct-Nov-Dec	12	27			
Nov-00	-	-	Nov-Dec	8	17	Nov-Dec-Jan	11	36			
Dec-00	9	23	Dec-Jan	11	42	Dec-Jan-Feb	14	48			
Jan-01	13	61	Jan-Feb	16	52	Jan-Feb-Mar	15	50			
Feb-01	25	58	Feb-Mar	19	40						
Mar-01	14	27									
Max. GM	171			107			82				
Max. 90th		248			264			211			
Rollback GM	42			7			-				
Rollback 90th		20			25			6			
Rollback %					**25**						

Table B21. Running geometric means and 90th percentiles for Stranger Creek at Marble Valley Road (STRN15).

Period:	1 Month G.M.	1 Month 90TH		2 Month G.M.	2 Month 90TH		3 Month G.M.	3 Month 90TH		Total Survey G.M.	Total Survey 90TH
Mar-00	13	14	Mar-Apr	24	64	Mar-Apr-May	45	184	Mar 00-Mar 01	107	937
Apr-00	44	89	Apr-May	81	219	Apr-May-Jun	133	465			
May-00	150	150	May-Jun	232	445	May-Jun-Jul	446	1793			
Jun-00	359	417	Jun-Jul	768	**2385**	Jun-Jul-Aug	824	**2045**			
Jul-00	**1643**	1938	Jul-Aug	**1249**	2027	Jul-Aug-Sep	**956**	1875			
Aug-00	949	1452	Aug-Sep	730	1221	Aug-Sep-Oct	333	1674			
Sep-00	561	838	Sep-Oct	198	955	Sep-Oct-Nov	151	725			
Oct-00	70	100	Oct-Nov	63	89	Oct-Nov-Dec	109	921			
Nov-00	-	-	Nov-Dec	147	2712	Nov-Dec-Jan	45	500			
Dec-00	249	**10868**	Dec-Jan	45	616	Dec-Jan-Feb	44	425			
Jan-01	19	75	Jan-Feb	24	111	Jan-Feb-Mar	29	96			
Feb-01	40	159	Feb-Mar	44	100						
Mar-01	48	65									
Max. GM	1643			1249			956				
Max. 90th		10868			2385			2045			
Rollback GM	94			92			90				
Rollback 90th		99			92			91			
Rollback %					**92**						

Table B22. Running geometric means and 90th percentiles for Stensgar Creek off Zimmer Road (STEN14).

Period:	1 Month			2 Month			3 Month			Total Survey	
	G.M.	90TH		G.M.	90TH		G.M.	90TH		G.M.	90TH
Mar-00	27	75	Mar-Apr	34	79	Mar-Apr-May	31	77	Mar 00-Mar 01	45	239
Apr-00	44	96	Apr-May	33	90	Apr-May-Jun	42	101			
May-00	25	97	May-Jun	40	115	May-Jun-Jul	85	483			
Jun-00	65	69	Jun-Jul	156	646	Jun-Jul-Aug	200	751			
Jul-00	**372**	1051	Jul-Aug	**350**	880	Jul-Aug-Sep	**235**	**1010**			
Aug-00	330	**1097**	Aug-Sep	187	**1006**	Aug-Sep-Oct	132	582			
Sep-00	106	975	Sep-Oct	84	321	Sep-Oct-Nov	93	308			
Oct-00	66	93	Oct-Nov	85	155	Oct-Nov-Dec	38	169			
Nov-00	-	-	Nov-Dec	26	172	Nov-Dec-Jan	21	84			
Dec-00	11	17	Dec-Jan	15	40	Dec-Jan-Feb	13	34			
Jan-01	18	57	Jan-Feb	14	47	Jan-Feb-Mar	17	50			
Feb-01	9	23	Feb-Mar	17	51						
Mar-01	32	34									
Max. GM	372			350			235				
Max. 90th		1097			1006			1010			
Rollback GM	74			72			58				
Rollback 90th		82			80			80			
Rollback %								**80**			

Table B23. Running geometric means and 90th percentiles for Blue Creek in Bluecreek (BLU13).

Period:	1 Month			2 Month			3 Month			Total Survey	
	G.M.	90TH		G.M.	90TH		G.M.	90TH		G.M.	90TH
Mar-00	128	170	Mar-Apr	152	255	Mar-Apr-May	165	330	Mar 00-Mar 01	182	1042
Apr-00	180	375	Apr-May	187	425	Apr-May-Jun	276	777			
May-00	195	654	May-Jun	**341**	1072	May-Jun-Jul	258	744			
Jun-00	597	1132	Jun-Jul	296	910	Jun-Jul-Aug	283	683			
Jul-00	147	212	Jul-Aug	194	318	Jul-Aug-Sep	246	569			
Aug-00	257	340	Aug-Sep	317	733	Aug-Sep-Oct	165	752			
Sep-00	392	1460	Sep-Oct	132	855	Sep-Oct-Nov	232	2274			
Oct-00	45	120	Oct-Nov	164	**3179**	Oct-Nov-Dec	125	1129			
Nov-00	-	-	Nov-Dec	249	3054	Nov-Dec-Jan	**411**	**3261**			
Dec-00	84	213	Dec-Jan	311	2336	Dec-Jan-Feb	191	1967			
Jan-01	**599**	**4061**	Jan-Feb	252	2833	Jan-Feb-Mar	147	1912			
Feb-01	44	806	Feb-Mar	36	207						
Mar-01	29	59									
Max. GM	599			341			411				
Max. 90th		4061			3179			3261			
Rollback GM	84			71			76				
Rollback 90th		96			94			94			
Rollback %								**94**			

Table B24. Running geometric means and 90th percentiles for Chewelah Creek at Alm Lane (CHEW10).											
Period:	1 Month			2 Month			3 Month			Total Survey	
	G.M.	90TH		G.M.	90TH		G.M.	90TH		G.M.	90TH
Mar-00	5	6	Mar-Apr	13	48	Mar-Apr-May	23	110	Mar 00-Mar 01	41	203
Apr-00	31	38	Apr-May	46	113	Apr-May-Jun	66	186			
May-00	68	219	May-Jun	95	243	May-Jun-Jul	118	278			
Jun-00	133	279	Jun-Jul	**154**	267	Jun-Jul-Aug	**136**	**294**			
Jul-00	**179**	281	Jul-Aug	138	**338**	Jul-Aug-Sep	131	276			
Aug-00	106	**398**	Aug-Sep	112	257	Aug-Sep-Oct	88	227			
Sep-00	119	204	Sep-Oct	80	202	Sep-Oct-Nov	67	173			
Oct-00	54	165	Oct-Nov	46	109	Oct-Nov-Dec	40	100			
Nov-00	-	-	Nov-Dec	33	81	Nov-Dec-Jan	31	69			
Dec-00	32	117	Dec-Jan	31	74	Dec-Jan-Feb	21	122			
Jan-01	30	70	Jan-Feb	18	71	Jan-Feb-Mar	20	106			
Feb-01	7	225	Feb-Mar	13	125						
Mar-01	25	49									
Max. GM	179			154			136				
Max. 90th		398			338			294			
Rollback GM	45			36			27				
Rollback 90th		50			41			32			
Rollback %					**41**						

Table B25. Running geometric means and 90th percentiles for Sherwood Creek at Cottonwood Creek Rd (SHER9).											
Period:	1 Month			2 Month			3 Month			Total Survey	
	G.M.	90TH		G.M.	90TH		G.M.	90TH		G.M.	90TH
Mar-00	10	17	Mar-Apr	5	20	Mar-Apr-May	8	34	Mar 00-Mar 01	23	273
Apr-00	2	12	Apr-May	7	46	Apr-May-Jun	13	95			
May-00	20	44	May-Jun	30	84	May-Jun-Jul	52	204			
Jun-00	46	149	Jun-Jul	83	276	Jun-Jul-Aug	65	192			
Jul-00	152	323	Jul-Aug	77	241	Jul-Aug-Sep	**122**	491			
Aug-00	40	70	Aug-Sep	**109**	612	Aug-Sep-Oct	43	514			
Sep-00	**299**	**1187**	Sep-Oct	45	1084	Sep-Oct-Nov	93	**2940**			
Oct-00	7	62	Oct-Nov	43	**3403**	Oct-Nov-Dec	16	553			
Nov-00	-	-	Nov-Dec	27	2687	Nov-Dec-Jan	33	1001			
Dec-00	3	4	Dec-Jan	17	291	Dec-Jan-Feb	14	186			
Jan-01	38	781	Jan-Feb	22	487	Jan-Feb-Mar	15	187			
Feb-01	7	74	Feb-Mar	6	24						
Mar-01	5	5									
Max. GM	299			109			122				
Max. 90th		1187			3403			2940			
Rollback GM	67			9			19				
Rollback 90th		84			95			94			
Rollback %					**95**						

Table B26. Running geometric means and 90th percentiles for Cottonwood Creek at the mouth (COT8).

Period:	1 Month			2 Month			3 Month			Total Survey	
	G.M.	90TH		G.M.	90TH		G.M.	90TH		G.M.	90TH
Mar-00	4	5	Mar-Apr	12	60	Mar-Apr-May	16	70	Mar 00-Mar 01	29	143
Apr-00	31	107	Apr-May	30	80	Apr-May-Jun	36	83			
May-00	29	93	May-Jun	38	85	May-Jun-Jul	60	180			
Jun-00	50	61	Jun-Jul	86	197	Jun-Jul-Aug	103	270			
Jul-00	**149**	190	Jul-Aug	**147**	340	Jul-Aug-Sep	**131**	**305**			
Aug-00	145	**608**	Aug-Sep	123	**358**	Aug-Sep-Oct	97	293			
Sep-00	104	310	Sep-Oct	79	224	Sep-Oct-Nov	63	191			
Oct-00	60	211	Oct-Nov	45	134	Oct-Nov-Dec	24	98			
Nov-00	-	-	Nov-Dec	13	32	Nov-Dec-Jan	17	39			
Dec-00	9	18	Dec-Jan	15	38	Dec-Jan-Feb	14	34			
Jan-01	20	47	Jan-Feb	17	41	Jan-Feb-Mar	15	50			
Feb-01	12	29	Feb-Mar	12	52						
Mar-01	12	135									
Max. GM	149			147			131				
Max. 90th		608			358			305			
Rollback GM	33			32			24				
Rollback 90th		68			45			35			
Rollback %					**45**						

Table B27. Running geometric means and 90th percentiles for Huckleberry Creek at the mouth (HUC7).

Period:	1 Month			2 Month			3 Month			Total Survey	
	G.M.	90TH		G.M.	90TH		G.M.	90TH		G.M.	90TH
Mar-00	4	68	Mar-Apr	6	35	Mar-Apr-May	8	36	Mar 00-Mar 01	18	132
Apr-00	9	23	Apr-May	11	23	Apr-May-Jun	17	47			
May-00	15	17	May-Jun	24	54	May-Jun-Jul	44	192			
Jun-00	38	80	Jun-Jul	76	276	Jun-Jul-Aug	117	**439**			
Jul-00	153	**457**	Jul-Aug	**207**	449	Jul-Aug-Sep	**134**	436			
Aug-00	**279**	318	Aug-Sep	126	**497**	Aug-Sep-Oct	74	330			
Sep-00	56	189	Sep-Oct	38	95	Sep-Oct-Nov	40	89			
Oct-00	26	30	Oct-Nov	32	52	Oct-Nov-Dec	18	62			
Nov-00	-	-	Nov-Dec	15	73	Nov-Dec-Jan	8	32			
Dec-00	8	28	Dec-Jan	6	17	Dec-Jan-Feb	7	29			
Jan-01	5	14	Jan-Feb	6	12	Jan-Feb-Mar	5	23			
Feb-01	10	190	Feb-Mar	6	42						
Mar-01	3	9									
Max. GM	279			207			134				
Max. 90th		457			497			439			
Rollback GM	65			52			26				
Rollback 90th		57			60			55			
Rollback %					**60**						

Table B28. Running geometric means and 90th percentiles for Waitts Lake Creek at Farm to Market Road (WLC6A).

Period:	1 Month			2 Month			3 Month			Total Survey	
	G.M.	90TH		G.M.	90TH		G.M.	90TH		G.M.	90TH
Mar-00	24	66	Mar-Apr	5	56	Mar-Apr-May	9	84	Mar 00-Mar 01	23	238
Apr-00	1	1	Apr-May	5	66	Apr-May-Jun	8	78			
May-00	26	120	May-Jun	25	60	May-Jun-Jul	55	399			
Jun-00	23	28	Jun-Jul	81	720	Jun-Jul-Aug	125	**911**			
Jul-00	278	**2197**	Jul-Aug	**289**	**1168**	Jul-Aug-Sep	**266**	888			
Aug-00	**300**	1054	Aug-Sep	260	706	Aug-Sep-Oct	110	725			
Sep-00	224	699	Sep-Oct	67	461	Sep-Oct-Nov	38	388			
Oct-00	20	33	Oct-Nov	12	40	Oct-Nov-Dec	18	79			
Nov-00	-	-	Nov-Dec	16	197	Nov-Dec-Jan	13	45			
Dec-00	-	-	Dec-Jan	17	49	Dec-Jan-Feb	9	49			
Jan-01	12	21	Jan-Feb	7	33	Jan-Feb-Mar	9	39			
Feb-01	2	7	Feb-Mar	7	56						
Mar-01	26	50									
Max. GM	300			289			266				
Max. 90th		2197			1168			911			
Rollback GM	67			66			63				
Rollback 90th		91			83			79			
Rollback %					**83**						

Table B29. Running geometric means and 90th percentiles for Jump-Off-Joe Creek at the mouth (JOJ5).

Period:	1 Month			2 Month			3 Month			Total Survey	
	G.M.	90TH		G.M.	90TH		G.M.	90TH		G.M.	90TH
Mar-00	3	33	Mar-Apr	3	15	Mar-Apr-May	7	64	Mar 00-Mar 01	12	132
Apr-00	2	12	Apr-May	10	107	Apr-May-Jun	19	171			
May-00	43	78	May-Jun	52	101	May-Jun-Jul	87	280			
Jun-00	62	147	Jun-Jul	123	**396**	Jun-Jul-Aug	145	**378**			
Jul-00	**244**	**422**	Jul-Aug	**220**	318	Jul-Aug-Sep	**149**	355			
Aug-00	199	239	Aug-Sep	117	279	Aug-Sep-Oct	48	323			
Sep-00	69	126	Sep-Oct	24	123	Sep-Oct-Nov	13	126			
Oct-00	8	14	Oct-Nov	4	20	Oct-Nov-Dec	3	11			
Nov-00	-	-	Nov-Dec	1	2	Nov-Dec-Jan	3	15			
Dec-00	1	3	Dec-Jan	4	18	Dec-Jan-Feb	4	15			
Jan-01	7	25	Jan-Feb	6	20	Jan-Feb-Mar	5	14			
Feb-01	4	5	Feb-Mar	3	5						
Mar-01	2	4									
Max. GM	244			220			149				
Max. 90th		422			396			378			
Rollback GM	60			55			33				
Rollback 90th		53			50			48			
Rollback %				**55**							

Table B30. Running geometric means and 90th percentiles for Deer Creek at Deer Creek Road (DEC3).

Period:	1 Month G.M.	1 Month 90TH		2 Month G.M.	2 Month 90TH		3 Month G.M.	3 Month 90TH		Total Survey G.M.	Total Survey 90TH
Mar-00	5	7	Mar-Apr	3	9	Mar-Apr-May	4	9	Mar 00-Mar 01	11	125
Apr-00	2	7	Apr-May	3	9	Apr-May-Jun	6	34			
May-00	5	12	May-Jun	10	54	May-Jun-Jul	29	388			
Jun-00	20	175	Jun-Jul	71	**773**	Jun-Jul-Aug	62	442			
Jul-00	**252**	**969**	Jul-Aug	110	569	Jul-Aug-Sep	**115**	**521**			
Aug-00	48	182	Aug-Sep	77	340	Aug-Sep-Oct	94	338			
Sep-00	125	766	Sep-Oct	**132**	427	Sep-Oct-Nov	77	489			
Oct-00	140	345	Oct-Nov	56	470	Oct-Nov-Dec	17	265			
Nov-00	-	-	Nov-Dec	4	20	Nov-Dec-Jan	3	10			
Dec-00	3	19	Dec-Jan	3	8	Dec-Jan-Feb	2	7			
Jan-01	3	7	Jan-Feb	2	6	Jan-Feb-Mar	3	8			
Feb-01	1	3	Feb-Mar	2	11						
Mar-01	4	37									
Max. GM	252			132			115				
Max. 90th		969			773			521			
Rollback GM	61			25			14				
Rollback 90th		80			75			62			
Rollback %					**75**						

Table B31. Running geometric means and 90th percentiles for Sheep Creek at Long Prairrie Road (SCH2).

Period:	1 Month G.M.	1 Month 90TH		2 Month G.M.	2 Month 90TH		3 Month G.M.	3 Month 90TH		Total Survey G.M.	Total Survey 90TH
Mar-00	12	27	Mar-Apr	27	114	Mar-Apr-May	31	101	Mar 00-Mar 01	54	225
Apr-00	58	217	Apr-May	49	114	Apr-May-Jun	66	170			
May-00	42	67	May-Jun	71	180	May-Jun-Jul	156	885			
Jun-00	120	250	Jun-Jul	303	**1272**	Jun-Jul-Aug	**259**	824			
Jul-00	**765**	**774**	Jul-Aug	**380**	1076	Jul-Aug-Sep	236	**902**			
Aug-00	189	229	Aug-Sep	131	308	Aug-Sep-Oct	84	254			
Sep-00	91	282	Sep-Oct	56	149	Sep-Oct-Nov	46	128			
Oct-00	35	43	Oct-Nov	29	45	Oct-Nov-Dec	36	59			
Nov-00	-	-	Nov-Dec	37	73	Nov-Dec-Jan	35	58			
Dec-00	50	60	Dec-Jan	39	58	Dec-Jan-Feb	36	55			
Jan-01	34	51	Jan-Feb	33	48	Jan-Feb-Mar	29	50			
Feb-01	30	48	Feb-Mar	25	46						
Mar-01	21	48									
Max. GM	765			380			259				
Max. 90th		774			1272			902			
Rollback GM	87			74			62				
Rollback 90th		75			85			78			
Rollback %					**85**						

Table B32. Running geometric means and 90th percentiles for Sheep Creek in Springdale (SCH1).

Period:	1 Month			2 Month			3 Month			Total Survey	
	G.M.	90TH		G.M.	90TH		G.M.	90TH		G.M.	90TH
Mar-00	10	35	Mar-Apr	18	60	Mar-Apr-May	20	52	Mar 00-Mar 01	27	78
Apr-00	33	60	Apr-May	28	43	Apr-May-Jun	29	46			
May-00	24	29	May-Jun	27	42	May-Jun-Jul	43	126			
Jun-00	29	62	Jun-Jul	58	184	Jun-Jul-Aug	**59**	169			
Jul-00	**115**	**210**	Jul-Aug	**84**	**209**	Jul-Aug-Sep	52	**170**			
Aug-00	61	208	Aug-Sep	35	104	Aug-Sep-Oct	22	76			
Sep-00	20	22	Sep-Oct	13	25	Sep-Oct-Nov	11	23			
Oct-00	9	11	Oct-Nov	8	11	Oct-Nov-Dec	17	62			
Nov-00	-	-	Nov-Dec	25	120	Nov-Dec-Jan	30	77			
Dec-00	50	53	Dec-Jan	39	54	Dec-Jan-Feb	39	52			
Jan-01	34	43	Jan-Feb	36	46	Jan-Feb-Mar	27	55			
Feb-01	40	47	Feb-Mar	21	55						
Mar-01	11	14									
Max. GM	115			84			59				
Max. 90th		210			209			170			
Rollback GM	14			-			-				
Rollback 90th		5			4			-			
Rollback %					**4**						

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October 9, 2000

Randy Coots
DOE
300 Desmund Dr.
Olympia, WA 98504-7710

Dear Randy,

I've enclosed the data and results of the first batch of samples you sent me from the Colville TMDL Project (3 samples collected August 8th, 2000). I've included individual sample reports, a table of similarity indices, a summary table, and a disk containing the data.

Species Present

Dominant and common algae observed in these 3 samples were Navicula cryptocephala, Achnanthes minutissima, Navicula tripunctata, and Scenedesmus quadricauda. Navicula and Achnanthes species are periphytic; Scenedesmus is planktonic.

Phytoplankton Abundance

The total algal densities ranged from 1,250 to 2,276 per mL; the total algal biovolumes ranged from 435,154 to 1,113,007 cubic micrometers per mL; and the trophic state indices ranged from 43.9 to 50.6. The algal abundances indicate higher end mesotrophic waters (TSI above 50 is considered eutrophic).

Comparison Between Samples

Similarity indices (SI's) compare the relative density of each species between two samples; it ranges from 0 for totally dissimilar samples, to 100 for samples with identical phytoplankton communities.

The SI's for these 3 samples ranged from 54 to 68, indicating moderate similarity between these samples. Samples from Greenwood and 12 Mile Rd were dominated by Navicula cryptocephala, whereas the sample from Betteridge was dominated by Achnanthes minutissima. Navicula tripunctata was common in all three samples. The sample from Betteridge was less similar than between the other samples.

Trophic state indices (TSI's) are calculated from the total sample biovolume, and they provide a good estimate of algae abundance. The sample from Betteridge had the least algae (TSI=43.9), followed by 12 Mile Rd (TSI=47.4), and Greenwood (TSI=50.6). The differences in algal abundance between samples is moderate.

Randy, if you have any further questions, please feel free to contact me. I thank you for this opportunity to work with you.

Best,

Jim Sweet

Jim Sweet

PHYTOPLANKTON SAMPLE ANALYSIS

SAMPLE: Colville, Greenwood (32-8280)

SAMPLE DATE: 00-08-08

TOTAL DENSITY (#/ml): 2276

TOTAL BIOVOLUME (cu.uM/ml): 1113007

TROPHIC STATE INDEX: 50.6

DIVERSITY INDEX: 4.16

--	SPECIES	DENSITY	PCT	BIOVOL	PCT
1	Navicula cryptocephala	349	15.3	64473	5.8
2	Navicula tripunctata	287	12.6	321440	28.9
3	Scenedesmus quadricauda	205	9.0	58630	5.3
4	Navicula cryptocephala veneta	205	9.0	19475	1.7
5	Cymbella minuta	144	6.3	53095	4.8
6	Cymbella affinis	123	5.4	221400	19.9
7	Melosira varians	103	4.5	79950	7.2
8	Nitzschia paleacea	103	4.5	10045	0.9
9	Amphora perpusilla	103	4.5	17015	1.5
10	Achnanthes minutissima	82	3.6	4100	0.4
11	Navicula graciloides	62	2.7	26753	2.4
12	Diatoma vulgare	62	2.7	120540	10.8
13	Nitzschia acicularis	62	2.7	17220	1.5
14	Gomphonema angustatum	62	2.7	11070	1.0
15	Cocconeis placentula	41	1.8	18860	1.7
16	Rhoicosphenia curvata	41	1.8	4797	0.4
17	Rhodomonas minuta	41	1.8	820	0.1
18	Scenedesmus bijuga	21	0.9	2870	0.3
19	Nitzschia dissipata	21	0.9	5515	0.5
20	Navicula sp.	21	0.9	3075	0.3
21	Chlamydomonas sp.	21	0.9	6663	0.6
22	Cyclotella meneghiniana	21	0.9	7790	0.7
23	Navicula sp.	21	0.9	3075	0.3
24	Achnanthes lanceolata	21	0.9	3690	0.3
25	Navicula gregaria	21	0.9	3588	0.3
26	Gomphonema subclavatum	21	0.9	24600	2.2
27	Nitzschia frustulum	21	0.9	2460	0.2

PHYTOPLANKTON SAMPLE ANALYSIS

SAMPLE: Colville, 12 Mile Rd (32-8288)

SAMPLE DATE: 00-08-08

TOTAL DENSITY (#/ml): 1865

TOTAL BIOVOLUME (cu.uM/ml): 712718

TROPHIC STATE INDEX: 47.4

DIVERSITY INDEX: 4.15

	SPECIES	DENSITY	PCT	BIOVOL	PCT
1	Navicula cryptocephala	413	22.1	76364	10.7
2	Scenedesmus quadricauda	214	11.5	57040	8.0
3	Navicula tripunctata	183	9.8	205473	28.8
4	Nitzschia dissipata	92	4.9	24675	3.5
5	Cocconeis placentula	76	4.1	35163	4.9
6	Achnanthes minutissima	76	4.1	3822	0.5
7	Achnanthes lanceolata	76	4.1	13759	1.9
8	Navicula capitata	61	3.3	29353	4.1
9	Nitzschia paleacea	61	3.3	5993	0.8
10	Melosira varians	61	3.3	47699	6.7
11	Nitzschia acicularis	61	3.3	17123	2.4
12	Navicula graciloides	46	2.5	19951	2.8
13	Navicula cryptocephala veneta	46	2.5	4357	0.6
14	Nitzschia linearis	46	2.5	69897	9.8
15	Rhoicosphenia curvata	46	2.5	5366	0.8
16	Gomphonema angustatum	46	2.5	8256	1.2
17	Navicula pupula	31	1.6	8256	1.2
18	Cymbella minuta	31	1.6	11313	1.6
19	Amphora perpusilla	31	1.6	5076	0.7
20	Rhodomonas minuta	31	1.6	612	0.1
21	Gomphonema subclavatum	15	0.8	9173	1.3
22	Gomphonema olivaceum	15	0.8	3440	0.5
23	Navicula gregaria	15	0.8	2675	0.4
24	Chlamydomonas sp.	15	0.8	4969	0.7
25	Nitzschia recta	15	0.8	5122	0.7
26	Navicula decussis	15	0.8	2935	0.4
27	Nitzschia palea	15	0.8	2752	0.4
28	Diatoma vulgare	15	0.8	29965	4.2
29	Cymbella sinuata	15	0.8	2140	0.3

PHYTOPLANKTON SAMPLE ANALYSIS

SAMPLE: Colville, Betteridge (32-8301)

SAMPLE DATE: 00-08-08

TOTAL DENSITY (#/ml): 1250

TOTAL BIOVOLUME (cu.uM/ml): 435154

TROPHIC STATE INDEX: 43.9

DIVERSITY INDEX: 4.48

	SPECIES	DENSITY	PCT	BIOVOL	PCT
1	Achnanthes minutissima	123	9.8	6128	1.4
2	Cocconeis placentula	123	9.8	56375	13.0
3	Navicula tripunctata	110	8.8	123535	28.4
4	Navicula cryptocephala veneta	98	7.8	9314	2.1
5	Navicula cryptocephala	98	7.8	18138	4.2
6	Nitzschia dissipata	98	7.8	26374	6.1
7	Achnanthes lanceolata	74	5.9	13236	3.0
8	Navicula graciloides	49	3.9	21324	4.9
9	Nitzschia paleacea	49	3.9	4804	1.1
10	Amphora perpusilla	49	3.9	8138	1.9
11	Gomphonema angustatum	37	2.9	6618	1.5
12	Navicula gregaria	25	2.0	4289	1.0
13	Cymbella sinuata	25	2.0	3432	0.8
14	Navicula cascadensis	25	2.0	1471	0.3
15	Nitzschia linearis	25	2.0	37355	8.6
16	Fragilaria construens	25	2.0	6863	1.6
17	Cymbella minuta	25	2.0	13604	3.1
18	Nitzschia fonticola	25	2.0	1029	0.2
19	Nitzschia sp.	12	1.0	1471	0.3
20	Cymbella affinis	12	1.0	22060	5.1
21	Fragilaria pinnata	12	1.0	735	0.2
22	Surirella ovata	12	1.0	3554	0.8
23	Nitzschia sp.	12	1.0	1471	0.3
24	Gomphonema subclavatum	12	1.0	7353	1.7
25	Nitzschia acicularis	12	1.0	3432	0.8
26	Nitzschia palea	12	1.0	2206	0.5
27	Navicula anglica	12	1.0	4412	1.0
28	Synedra rumpens	12	1.0	1716	0.4
29	Melosira varians	12	1.0	15932	3.7
30	Rhoicosphenia curvata	12	1.0	1434	0.3
31	Navicula capitata	12	1.0	5883	1.4
32	Nitzschia frustulum	12	1.0	1471	0.3

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November 18, 2000

Randy Coots
DOE
300 Desmund Dr.
Olympia, WA 98504-7710

Dear Randy,

I've enclosed the data and results of the second batch of samples you sent me from the Colville TMDL Project (3 samples collected in September, 2000). I've included individual sample reports, a table of similarity indices, a summary table, and a disk containing the data.

Species Present

Dominant and common algae observed in Greenwood and 12 Mile Rd samples were Navicula cryptocephala, Navicula cryptocephala veneta, and Navicula tripunctata. Common algae at the Betteridge site were different, and included Cocconeis placentula and Achnanthes minutissima. All of these species are periphytic (growing attached).

Phytoplankton Abundance

The total algal densities ranged from 840 to 1,592 per mL; the total algal biovolumes ranged from 289,077 to 786,877 cubic micrometers per mL; and the trophic state indices ranged from 40.9 to 48.1. The algal abundances indicate higher end mesotrophic waters (TSI above 50 is considered eutrophic).

Comparison Between Samples

Similarity indices (SI's) compare the relative density of each species between two samples; it ranges from 0 for totally dissimilar samples, to 100 for samples with identical phytoplankton communities.

The SI's for these 3 samples ranged from 43 to 67, indicating moderate similiarity between these samples. As with the samples collected August, Navicula species were dominant at Greenwood and 12 Mile Rd, whereas Betteridge was dominanted by Cocconeis placentula and Achnanthes minutissima. The sample from Betteridge was less similar than between the other samples.

Trophic state indices (TSI's) are calculated from the total sample biovolume, and they provide a good estimate of algae abundance. The sample from Betteridge had the least algae (TSI=40.9), followed by 12 Mile Rd (TSI=45.7) and Greenwood (TSI=48.1). This was the same pattern observed in August.

In general, these samples collected in September were similar in terms of species present and their abundances as from August.

Randy, if you have any further questions, please feel free to contact me. I thank you for this opportunity to work with you.

Best,

Jim Sweet

Jim Sweet

PHYTOPLANKTON SAMPLE ANALYSIS

SAMPLE: Colville, Greenwood (38-8280)

SAMPLE DATE: 00-09-20

TOTAL DENSITY (#/ml): 1592

TOTAL BIOVOLUME (cu.uM/ml): 786877

TROPHIC STATE INDEX: 48.1

DIVERSITY INDEX: 3.90

	SPECIES	DENSITY	PCT	BIOVOL	PCT
1	Navicula cryptocephala	413	25.9	76346	9.7
2	Navicula tripunctata	192	12.0	214593	27.3
3	Navicula cryptocephala veneta	162	10.2	15402	2.0
4	Cocconeis placentula	103	6.5	47458	6.0
5	Diatoma vulgare	88	5.6	173326	22.0
6	Cymbella affinis	74	4.6	132647	16.9
7	Scenedesmus quadricauda	74	4.6	14370	1.8
8	Navicula graciloides	59	3.7	25645	3.3
9	Cymbella sinuata	59	3.7	8254	1.0
10	Nitzschia paleacea	44	2.8	4333	0.6
11	Gomphonema angustatum	29	1.9	5306	0.7
12	Amphora perpusilla	29	1.9	4893	0.6
13	Achnanthes minutissima	29	1.9	1474	0.2
14	Nitzschia palea	29	1.9	5306	0.7
15	Closteriopsis longissima	15	0.9	5247	0.7
16	Nitzschia innominata	15	0.9	707	0.1
17	Nitzschia fonticola	15	0.9	619	0.1
18	Achnanthes clevei	15	0.9	2211	0.3
19	Rhoicosphenia curvata	15	0.9	1724	0.2
20	Nitzschia acicularis	15	0.9	4127	0.5
21	Caloneis ventricosa minuta	15	0.9	4127	0.5
22	Gomphonema subclavatum	15	0.9	8843	1.1
23	Navicula cascadensis	15	0.9	884	0.1
24	Melosira varians	15	0.9	9580	1.2
25	Cymbella minuta	15	0.9	5453	0.7
26	Surirella ovata	15	0.9	4274	0.5
27	Achnanthes lanceolata	15	0.9	2653	0.3
28	Navicula capitata	15	0.9	7075	0.9

PHYTOPLANKTON SAMPLE ANALYSIS

SAMPLE: Colville, 12 Mile Rd (38-8288)

SAMPLE DATE: 00-09-19

TOTAL DENSITY (#/ml): 1207

TOTAL BIOVOLUME (cu.uM/ml): 561312

TROPHIC STATE INDEX: 45.7

DIVERSITY INDEX: 4.13

	SPECIES	DENSITY	PCT	BIOVOL	PCT
1	Navicula tripunctata	178	14.7	198866	35.4
2	Navicula cryptocephala veneta	166	13.7	15744	2.8
3	Navicula cryptocephala	142	11.8	26279	4.7
4	Cocconeis placentula	107	8.8	49006	8.7
5	Scenedesmus quadricauda	83	6.9	16158	2.9
6	Navicula graciloides	71	5.9	30895	5.5
7	Cymbella affinis	47	3.9	85228	15.2
8	Rhoicosphenia curvata	47	3.9	5540	1.0
9	Achnanthes minutissima	36	2.9	1776	0.3
10	Amphora perpusilla	36	2.9	5895	1.1
11	Gomphonema angustatum	36	2.9	6392	1.1
12	Cymbella minuta	24	2.0	8760	1.6
13	Nitzschia linearis	24	2.0	36080	6.4
14	Rhodomonas minuta	24	2.0	473	0.1
15	Pinnularia sp.	24	2.0	9470	1.7
16	Navicula sp.	24	2.0	3551	0.6
17	Achnanthes lanceolata	12	1.0	2131	0.4
18	Fragilaria construens venter	12	1.0	5682	1.0
19	Cymbella sinuata	12	1.0	1657	0.3
20	Gomphonema subclavatum	12	1.0	7102	1.3
21	Synedra parasitica	12	1.0	1657	0.3
22	Navicula gregaria	12	1.0	2072	0.4
23	Nitzschia acicularis	12	1.0	3314	0.6
24	Achnanthes clevei	12	1.0	1776	0.3
25	Melosira varians	12	1.0	7694	1.4
26	Navicula menisculus upsaliensis	12	1.0	2427	0.4
27	Diatoma vulgare	12	1.0	23201	4.1
28	Gomphonema tenellum	12	1.0	2486	0.4

PHYTOPLANKTON SAMPLE ANALYSIS

SAMPLE: Colville, Betteridge (38-8301)

SAMPLE DATE: 00-09-19

TOTAL DENSITY (#/ml): 840

TOTAL BIOVOLUME (cu.uM/ml): 289077

TROPHIC STATE INDEX: 40.9

DIVERSITY INDEX: 4.23

--	SPECIES	DENSITY	PCT	BIOVOL	PCT
1	Cocconeis placentula	146	17.4	67357	23.3
2	Achnanthes minutissima	107	12.8	5369	1.9
3	Achnanthes lanceolata	68	8.1	12300	4.3
4	Navicula cryptocephala veneta	68	8.1	6492	2.2
5	Navicula graciloides	68	8.1	29725	10.3
6	Navicula tripunctata	49	5.8	54667	18.9
7	Gomphonema angustatum	29	3.5	5271	1.8
8	Nitzschia paleacea	29	3.5	2870	1.0
9	Fragilaria construens	29	3.5	4264	1.5
10	Cymbella sinuata	20	2.3	2733	0.9
11	Navicula capitata	20	2.3	9371	3.2
12	Navicula gregaria	20	2.3	3417	1.2
13	Navicula cryptocephala	20	2.3	3612	1.2
14	Surirella ovata	20	2.3	5662	2.0
15	Cyclotella meneghiniana	10	1.2	3710	1.3
16	Navicula rhynchocephala	10	1.2	2880	1.0
17	Cymbella minuta	10	1.2	3612	1.2
18	Cyclotella stelligera	10	1.2	537	0.2
19	Pinnularia sp.	10	1.2	3905	1.4
20	Achnanthes clevei	10	1.2	1464	0.5
21	Nitzschia linearis	10	1.2	14877	5.1
22	Fragilaria vaucheria	10	1.2	2811	1.0
23	Frustulia rhomboides	10	1.2	10543	3.6
24	Melosira varians	10	1.2	6345	2.2
25	Navicula minuscula	10	1.2	439	0.2
26	Diatoma vulgare	10	1.2	19133	6.6
27	Nitzschia dissipata	10	1.2	2626	0.9
28	Amphora perpusilla	10	1.2	1620	0.6
29	Navicula sp.	10	1.2	1464	0.5

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Appendix C

Land cover breakdown of the Colville River Basin by category

Information was derived from GIS analysis of a national land cover data set developed by the Multi-resolution Land Characterization (MRLC) Consortium. The MRLC Consortium is a federal partnership of USGS, USEPA, US Forest Service and NOAA. The land cover codes defined within are those described by MRLC. The base data set was Landsat TM data, nominal-1992 acquisitions using a 30-meter resolution.

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Table C1. Colville River Basin Land Cover

Land Cover Code	Land Cover Description	Land Cover Area in $Miles^2$	Land Cover Percent of Basin
11	Open Water	8.36	0.82
21	Low Intensity Residential	7.04	0.69
22	High Intensity Residential	0.001	0.0001
23	Commercial/Industrial/Transportation	3.32	0.33
31	Bare Rocks/Sand/Clay	0.62	0.061
32	Quarries/Strip Mines/Gravel Pits	0.54	0.053
33	Transitional	61.2	6.02
41	Deciduous Forest	4.07	0.40
42	Evergreen Forest	756	74.4
43	Mixed Forest	20.7	2.04
51	Shrubland	19.1	1.88
61	Orchards/Vineyards/Other	0.031	0.0031
71	Grasslands/Herbaceous	33.8	3.33
81	Pasture/Hay	60.4	5.94
82	Row crops	13.3	1.31
83	Small Grains	13.7	1.35
84	Fallow	11.4	1.12
85	Urban/Recreational Grasses	0.18	0.018
91	Woody Wetlands	2.29	0.23
92	Emergent Herbaceous Wetlands	0.25	0.025
	Total Area - $Miles^2$	1016	

Percent of Land Cover by Category for the Colville River Basin

Category (codes)	Land Cover Percent of Basin
Agricultural (61,81,82,83,84)	9.72
Barren Ground (31,32,33)	6.13
Development (21,22,23,85)	1.04
Forests (41,42,43,51,71,91)	82.3
Open Water (11,92)	0.85

NOTE: Descriptions of individual land cover codes follow in text.

MRLC Land Cover Code Definitions – as described by MRLC

Water – All areas of open water.

11. Open water - All areas of open water; typically 25 percent or greater cover of water (per cell).

Developed – Areas characterized by a high percentage (30 or greater) of constructed materials (*e.g.,* asphalt, concrete, buildings, etc.).

21. Low Intensity Residential – Includes areas with a mixture of constructed materials and vegetation. Constructed materials account for 30-80 percent of the cover. Vegetation may account for 20-70 percent of the cover. These areas most commonly include single-family housing units. Population densities will be lower than in high intensity residential areas.

22. High Intensity Residential – Includes highly developed areas where people reside in high numbers. Examples include apartment complexes and row houses. Vegetation accounts for less than 20 percent of the cover. Constructed materials account for 80 – 100 percent of the cover.

23. Commercial/Industrial/Transportation – Includes infrastructure (*e.g.,* roads, railroads, etc.) and all highly developed areas not classified as High Intensity Residential.

Barren – Areas characterized by bare rock, gravel, sand, silt, clay, or other earthen material, with little or no "green" vegetation present regardless of its inherent ability to support life. Vegetation, if present, is more widely spaced and scrubby than that in the "green" vegetated categories; lichen cover may be extensive.

31. Barren Rock/Sand/Clay – Perennially barren areas of bedrock, desert pavement, scarps, talus, slides, volcanic material, glacial debris, beaches, and other accumulations of earthen materials.

32. Quarries/Strip Mines/Gravel Pits – Areas of extraction mining activities with significant surface expression.

33. Transitional – Areas of sparse vegetation cover (less than 25 percent of cover) that are dynamically changing from one land cover to another, often because of land use activities. Examples include forest clearcuts, a transition phase between forest and agricultural land, the temporary clearing of vegetation, and changes due to natural causes (*e.g.,* fire, flood, etc.).

Forested Upland – Areas characterized by tree cover (natural or semi-natural woody vegetation, generally greater than 6 meters tall); tree canopy accounts for 25-100 percent of the cover.

41. Deciduous Forest – Areas dominated by trees where 75 percent or more of the tree species shed foliage simultaneously in response to seasonal change.

42. Evergreen Forest – Areas dominated by trees where 75 percent or more of the species maintain their leaves all year. Canopy is never without green foliage

43. Mixed Forest – Areas dominated by trees where neither deciduous nor evergreen species represent more than 75 percent of the cover present.

Shrubland – Areas characterized by natural or semi-natural woody vegetation with aerial stems, generally less than 6 meters tall, with individuals or clumps not touching or interlocking. Both evergreen and deciduous species of true shrubs, young trees, and trees or shrubs that are small or stunted because of environmental conditions are included.

51. Shrubland – Areas dominated by shrubs; shrub canopy accounts for 25-100 percent of the cover. Shrub cover is generally greater than 25 percent when tree cover is less than 25 percent. Shrub cover may be less than 25 percent in cases when the cover of other life forms (*e.g.,* herbaceous or tree) is less than 25 percent and shrubs cover exceeds the cover of other life forms.

Non-natural Woody – Areas dominated by non-natural woody vegetation; non-natural woody vegetative canopy accounts for 25-100 percent of the cover. The non-natural woody classification is subject to the availability of sufficient ancillary data to differentiate non-natural woody vegetation from natural woody vegetation.

61. Orchards/Vineyards/Other – Orchards, vineyards, and other areas planted or maintained for the production of fruits, nuts, berries, or ornamentals.

Herbaceous Uplands – Upland areas characterized by natural or semi-natural herbaceous vegetation; herbaceous vegetation accounts for 75-100 percent of the cover.

71. Grasslands/Herbaceous – Areas dominated by upland grasses and forbs. In rare cases, herbaceous cover is less than 25 percent, but exceeds the combined cover of the woody species present. These areas are not subject to intensive management, but they are often utilized for grazing.

Planted/Cultivated – Areas characterized by herbaceous vegetation that has been planted or is intensively managed for the production of food, feed, or fiber; or is maintained in developed settings for specific purposes. Herbaceous vegetation accounts for 75-100 percent of the cover.

81. Pasture/Hay – Areas of grasses, legumes, or grass-legume mixtures planted for livestock grazing or the production of seed or hay crops.

82. Row Crops – Areas used for the production of crops, such as corn, soybeans, vegetables, tobacco, and cotton.

83. Small Grains – Areas used for the production of graminoid crops such as wheat, barley, oats, and rice.

84. Fallow – Areas used for the production of crops that are temporarily barren or with sparse vegetative cover as a result of being tilled in a management practice that incorporates prescribed alteration between cropping and tillage.

85. Urban/Recreational Grasses – Vegetation (primarily grasses) planted in developed settings for recreation, erosion control, or aesthetic purposed. Examples include parks, lawns, golf courses, airport grasses, and industrial site grasses.

Wetlands – Areas where the soil or substrate is periodically saturated with or covered with water as defined by Cowardin *et al.*

91. Woody Wetlands – Areas where forest or shrubland vegetation accounts for 25-100 percent of the cover and the soil or substrate is periodically saturated with or covered with water.

92. Emergent Herbaceous Wetlands – Areas where perennial herbaceous vegetation accounts for 75-100 percent of the cover and the soil or substrate is periodically saturated with or covered with water.

Appendix D

Sample site locations and land cover descriptions

Sample site descriptions were largely excerpted from the SCCD (1993) report: *Water Quality Summary for Colville River Watershed Ranking and Planning*. Sub-basin land cover percentages were derived from a GIS analysis of a national land cover data set developed by MRLC. Latitude and longitude for sample sites are in decimal degrees.

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Sampling Sites

SCH 1: Sheep Creek in Springdale, Washington - Lat: 48.0582 Long:117.7411

The most upstream sample site for study is located in the town of Springdale. Samples are collected downstream of a culvert below a large sandy fill under Main Street North. Substrate materials around the sampling area consisted of numerous large rocks. Flowing northwest through Springdale the creek has a uniform profile, following a series of steps from the uplands. Upstream of the sample site is generally undeveloped with an established riparian zone.

The majority of the sub-basin is forested with much of the open land in agriculture. Highway 292 runs east to west through the southern portion of the sub-basin and Highway 231 runs north to south through the middle.

Fifty-four square miles of land drain to the Sheep Creek in Springdale site. This accounts for about 5.3% of the Colville River watershed. Evergreen forest (73%) is the predominant land-cover in the sub-basin, followed by open water (6.9%), transitional areas (4.8%), and grasslands (3.9%).

SCH 2: Sheep Creek at Long Prairie Road – Lat: 48.0924 Long:117.7662

The sample site is just above a large arched culvert under Long Prairie Road, just east of the junction with Forest Center Road. The creek discharges to a large pool just below the culvert. Leaving the pool the creek meanders downstream. Samples are collected just above the culvert under Long Prairie Road.

Areas adjacent to the creek, both upstream and downstream of the sample site, are used for livestock grazing and crop production. Cattle have access to the creek upstream and downstream of the sample site.

Sixty-one square miles of land drain to the Sheep Creek at Long Prairie Road site. This accounts for about 6.0% of the Colville River watershed. Evergreen forest (72%) is the predominant land-cover in the sub-basin, followed by open water (6.2%), transitional areas (4.4%), and grasslands (4.3%).

DEC 3: Deer Creek at Deer Creek Road – Lat:48.1162 Long:117.7692

The sample site is located upstream of the large arched culvert under Deer Creek Road, between Highway 231 and Long Prairie Road. The immediate area is characterized by a well-established riparian zone, although the creek flows adjacent to the gravel surfaced Deer Creek Road for about one mile upstream. An irrigation diversion splits Deer Creek upstream of the sample site. Just downstream of the sample site Deer Creek and Sheep Creek flows combine to form the Colville River.

The substrate materials around the sampling area are comprised of cobble with boulders. There is recruitment of woody debris from the riparian zone.

Forty-two square miles of land drain to the Deer Creek at Deer Creek Road site. This accounts for about 4.1% of the Colville River watershed. Evergreen forest (80%) is the predominant land-cover in the sub-basin, followed by transitional areas (9.7%), mixed forest (3.6%), and hay/pasture (1.4%).

CR 4: Colville River at Betteridge Road, RM 56.8 – Lat:48.1504 Long:117.7348

The most upstream sample site on the Colville River is located above the town of Valley and the Lane Mountain plant. Upstream of the station is an aggregate plant, but previous investigations have not shown significant contributions from the plant to the river. Access to the sample site is from the bridge on Betteridge Road – a gravel road running east to west across the valley floor. Agricultural lands border the river upstream and downstream of the site. Much of the land is grazed because it is too wet to consistently raise grain crops.

Previous surveys found the river at this site often had a milky appearance. Continued investigation found that during early morning the river water was less milky than later morning. The source of the milky color is still open to debate.

The Colville River at Betteridge Road site drains 123 square miles of land. This accounts for about 12% of the Colville River watershed. Evergreen forest (73%) is the predominant land-cover in the sub-watershed, followed by transitional areas (5.8%), mixed forest (4.1%), and pasture/hay (3.8%).

JOJ 5: Jump-Off-Joe Creek at the Mouth – Lat:48.1509 Long:117.7343

This sampling site is adjacent to sampling site 4, with the creek running along the north side of Betteridge Road, before entering the river downstream of the bridge. Jump-Off-Joe Creek is the outflow of Jump-Off-Joe Lake and descends through a canyon before flowing through an old mill site, under Highway 231, through a livestock holding area, and on to the Colville River. The creek flows along the base of a road fill for approximately a quarter mile before discharge to the river.

The upland area of the sub-basin is drained by Grouse Creek, which discharges to Jump-Off-Joe Lake. Development around the lake is increasing.

Sixteen square miles of land drain to the Jump-Off-Joe Creek site. This accounts for about 1.5% of the Colville River watershed. Evergreen forest (77%) is the predominant land-cover in the sub-basin, followed by transitional areas (9.6%), pasture/hay (3.0%), and open water (2.7%).

CR 6: Colville River at Waitts Lake Road, RM 55.0 – Lat:48.1758 Long:117.7285

This sampling site is just downstream of the town of Valley. Agricultural lands border the river along this reach, both upstream and downstream. Much of the land is grazed because it is too wet to consistently raise grain crops. Less than one-mile upstream, Lane Mountain has a series of holding ponds adjacent to the river.

Substrate around the site has very little coarse materials and a high organic content. A dense aquatic plant growth is present in the river, while grass covers the riverbanks.

A discharge pipe coming from the river's east bank was found in a previous investigation. Elevated levels of fecal coliform, ammonia, nitrate-nitrite, and total phosphorus were measured in samples. A sewer system was installed for Valley/Waitts Lake in 1998 that should help control the discharge.

The Waitts Lake Road is paved and receives heavy truck use from material hauling to the Lane Mountain company. It is also a well-traveled road for accessing the western Colville River Valley.

The Colville River at Waitts Lake Road site drains 165 square miles of land. This is about 16% of the Colville River watershed area. Evergreen forest (72%) is the predominant land-cover in the sub-watershed, followed by transitional areas (6.1%), pasture/hay (4.8%), and mixed forest (3.9%).

WLC 6A: Waitts Lake Creek at Farm to Market Road – Lat:48.1846 Long:117.7568

This site is located upstream of the culvert under the Farm to Market Road. Downstream of the culvert, a seasonal pond is created by a board dam. The site is far enough upstream to avoid backwater effects of the pond. During the low flow period, water movement is non-existent at the site.

Forest and agricultural land surround Waitts Lake. A resort and numerous residences are present around the lake. Residences in the sub-basin use on-site sewage disposal systems.

The creek flows out of Waitts Lake and along Waitts Lake Road southeast before crossing under the road and dropping down to the valley floor.

Thirteen square miles of land drain to the Waitts Lake Creek at Farm to Market Road site. This accounts for about 1.2% of the Colville River watershed. Evergreen forest (72%) is the predominant land-cover in the sub-basin, followed by open water (6.7%), pasture/hay (6.1%), and transitional areas (4.8%).

HUC 7: Huckleberry Creek at the Mouth – Lat:48.2032 Long:117.7443

Access to the Huckleberry Creek site is from the Newton Road bridge, south about one half mile across private property, along the west bank of the Colville River. Winter and spring access could be limited due to snow and mud. If conditions prevent access to the primary site, the location of an alternate sample site will be upstream at the bridge crossing on Farm to Market Road over Huckleberry Creek.

Land adjacent to the sample site is cropland. Upstream of the site is a sediment basin behind a rock gabion dam. The dam was constructed to alleviate sediment build-up in the Colville River downstream of the confluence with Huckleberry Creek.

Forty-one square miles of land drain to the Huckleberry Creek site. This accounts for about 4.1% of the Colville River watershed. Evergreen forest (75%) is the predominant land-cover in the sub-basin, followed by transitional areas (15%), mixed forest (3.6%), and pasture/hay (1.6%).

COT 8: Cottonwood Creek at the Mouth – Lat:48.2275 Long:117.7058

Access to this site is through private property, where Farm to Market Road ends east of Highway 395. The creek flows through cropland and grazing areas for approximately one half mile before discharging to the Colville River. The area around the sampling site has been heavily grazed. Water quality samples are collected above a cattle wallow.

The lower portions of the sub-basin contain fertile farmland used for production of hay and grains as well as grazing cattle. Uplands contain a significant amount of Forest Service land.

Thirty-four square miles of land drain to the Cottonwood Creek site. This accounts for about 3.3% of the Colville River watershed. Evergreen forest (80%) is the predominant land-cover in the sub-basin, followed by transitional areas (8.1%), pasture/hay (4.2%), and grasslands (1.6%).

SHER 9: Sherwood Creek at Cottonwood Creek Road – Lat:48.2516 Long:117.6845

The sample site is located downstream of the culvert under Cottonwood Creek Road. The uplands above the sample site have a few houses, while downstream the creek borders agricultural lands until discharge to the Colville River. Well upstream of the sample site, an earthen dam, which contained Horseshoe Lake, failed in 1974. The resulting debris torrent created a large canyon and deposited gravel and fine sediment throughout the lower reaches of Sherwood Creek. This material is evident downstream of the sample site, piled on either bank as the result of previous dredging activities.

Cottonwood Creek Road is a paved, north to south oriented road, located on the east side of the Colville River valley. Horseshoe Lake Road is graveled, and runs adjacent to portions of the creek upstream of the sampling site.

Twelve square miles of land drain to the Sherwood Creek site. This accounts for about 1.1% of the Colville River watershed. Forest Service land makes up a large portion of the sub-basin, while farmland is found along the Colville River in the western portion of the drainage and on terraces higher up. Evergreen forest (91%) is the predominant land-cover in the sub-basin, followed by transitional areas (7.1%) and pasture/hay (0.94%).

CHEW 10: Chewelah Creek at Alm Lane – Lat:48.2663 Long:117.7218

This site is located downstream of the City of Chewelah. The creek flows through a city park, business, and residential areas, before discharge to the Colville River south of the sample site.

The creek is used for recreation and flows under a major highway and several city streets upstream of the site.

The portion of the creek that flows through the city and on to the river falls under the Shorelines Protection Act because its average discharge is greater than 20 cubic feet per second. The City of Chewelah is developing a Shorelines Management Plan. Stevens County already has such a plan for the portions of the creek under their jurisdiction.

Ninety-three square miles of land drain to the Chewelah Creek site, which includes the City of Chewelah with a population of about 2000. The road network in the drainage makes many portions of the creek readily accessible to the public. The Chewelah Creek sub-basin accounts for about 9.2% of the Colville River watershed. Evergreen forest (81%) is the predominant land-cover, followed by transitional areas (10.5%), pasture/hay (3.0%), and grasslands (1.5%).

CR 11: Colville River at Alm Lane, RM 45.7 – Lat:48.2663 Long:117.7396

The sampling site is located upstream of the City of Chewelah sewage lagoons on the west side of the valley. Alm Lane crosses the river at this point. It is a paved road and a major access to the west side of the valley.

The land adjacent to the river upstream and downstream of the sampling site is used for agricultural purposes. A horse ranch is located downstream and the horses are restricted to selected access points but this has not been consistent. Samples are collected upstream of the horse access points.

River substrate material at this site is predominantly sandy. There are aquatic plants along the banks and in the center of the channel in some areas.

The Colville River at Alm Lane drains 390 square miles of land. This accounts for about 38% of the Colville River watershed. Evergreen forest (74%) is the predominant land-cover in the sub-watershed, followed by transitional areas (8.1%), pasture/hay (5.1%), and grasslands (2.8%).

CR 12: Colville River at Blue Creek, RM 37.1 – Lat:48.3201 Long:117.8185

Located downstream of the City of Chewelah, this site is affected by flows from the community of Bluecreek. Bluecreek is a small community with many residences along Blue Creek, a stream flowing into the Colville River above the sample site.

Flows at this site have higher velocities than other Colville River sites. The river is shallow through the reach and substrate is composed of large cobble and gravel. The bottom appears to be well armored for all but the higher flows. Highway 395 parallels the river at this site and Blue Creek Road crosses the river via a paved surface bridge.

Draining 427 square miles of land, the Colville River at Blue Creek site accounts for about 42% of the watershed. Evergreen forest (73%) is the predominant land-cover in the sub-watershed, followed by transitional areas (8.1%), pasture/hay (5.3%), and grasslands (3.0%).

BLU 13: Blue Creek in the Community of Bluecreek – Lat:48.3194 Long:117.8195

Blue Creek watershed is made up of Blue Creek and Dry Creek – an intermittent stream. The sample site is located just upstream of the culvert under Blue Creek Road and below the railroad crossing.

Blue Creek flows through agricultural lands before passing through the community of Bluecreek. There are many residences along the creek. All of these residences have on-site sewage disposal systems. Upstream of the community are two livestock holding areas, one on Blue Creek and the other on Dry Creek, above its confluence with Blue Creek.

Sixteen square miles of land drain to the Blue Creek site. The Blue Creek sub-basin accounts for about 1.6% of the Colville River watershed. Evergreen forest (78%) is the predominant land-cover in the sub-basin, followed by transitional areas (9.7%), mixed forest (4.0%), and pasture/hay (3.2%).

STEN 14: Stensgar Creek at the Mouth – Lat:48.3488 Long:117.8450

Access to the site is through private property off Zimmer Road via a two-track grass road. Snow could impact access to the site. If snow prevents access an alternative sample location will be upstream at the Zimmer Road crossing over Stensgar Creek.

The Stensgar Creek sub-basin is rural and contains some dairies. The creek flows through agricultural lands for a significant distance above the sample point. Some of the land is cropland and some is used to graze dairy and beef cattle.

During a previous investigation, the creek did not flow to the river for a portion of the dry season. It was assumed irrigation extractions upstream, in addition to it being a dry year, were the cause.

Fifty-six square miles of land drain to the Stensgar Creek site. The Stensgar Creek sub-basin accounts for about 5.5% of the Colville River watershed. Evergreen forest (72%) is the predominant land-cover in the sub-basin, followed by pasture/hay (9.8%), transitional areas (5.7%), and grasslands (2.1%).

STRN 15: Stranger Creek at Marble Valley Basin Road – Lat:48.3723 Long:117.8581

Upstream of the culvert under Marble Valley Basin Road, this site is near the Northwest Alloy Magnesium Plant in Addy. The stream reach immediately above the sampling point flows along the toe of the fillslope for Marble Valley Basin Road. The fill is well vegetated with grass. The Marble Valley Basin Road receives a great deal of heavy truck traffic due to gravel hauling from the Northwest Alloy plant.

The Stranger Creek sub-basin is diversified with agricultural land along the river and creek, forests on the side hills and mountains, and a major industrial complex, Northwest Alloy, near Addy.

Forty-three square miles of land drain to the Stranger Creek site. This accounts for about 4.2% of the Colville River watershed. Evergreen forest (72%) is the predominant land-cover in the sub-basin, followed by pasture/hay (7.7%), transitional areas (6.8%), and grasslands (3.2%).

CR 16: Colville River at 12 Mile Road, RM 28.0 – Lat:48.4031 Long:117.8526

The sample site is located downstream of Addy and the Northwest Alloy Magnesium Plant. The Burlington Northern right-of-way runs along the east bank of the river. There is evidence of debris from railroad maintenance operations being cast into the river. Trucks hauling gravel from Northwest Alloy heavily use the 12 Mile Road bridge.

The land adjacent to the river upstream and downstream of the sampling site is primarily used for agricultural purposes. Most of the land is used for hay and grain production but there is some livestock grazing.

The substrate material along the west bank is soft with aquatic plant growth present. The remainder of the substrate is primarily fine material with scattered coarse particles.

The Colville River at 12 Mile Road drains 558 square miles of land. This accounts for about 55% of the Colville River watershed. Evergreen forest (73%) is the predominant land-cover in the sub-watershed, followed by transitional areas (7.4%), pasture/hay (6.1%), and grassland (3.0%).

LPOR 17: Little Pend Oreille River at Highway 395 – Lat:48.4597 Long:117.8806

This sample site is located downstream of the Highway 395 bridge and upstream of the Burlington Northern railroad bridge. Upstream of the site, the river flows through a residential area, Arden. Downstream of the site is the Stimson Lumber Company mill.

Highway 395 is a major north-south route from Canada and northeastern Washington, to Spokane and locations farther south. There is a great deal of heavy truck traffic across the bridge.

The substrate materials at this site are composed of cobble and large gravel. The river gradient keeps flows moving well through the reach.

The U.S. Fish and Wildlife Service administers a large portion of the sub-basin as the Little Pend Oreille Wildlife Refuge. The headwaters of the river are in the Little Pend Oreille Lakes area, a popular recreational destination.

The Little Pend Oreille River sub-basin is the largest in the Colville River watershed. One hundred and eighty-seven square miles of land drain to the Little Pend Oreille River site. This accounts for about 18.5% of the Colville River watershed. Evergreen forest (84%) is the predominant land-cover in the sub-basin, followed by transitional areas (5.0%), pasture/hay (3.5%), and grasslands (2.2%).

CR 18: Colville River at Arden Hill Road, RM 23.0 – Lat:48.4599 Long:117.8868

The sample site is located upstream of the Arden Hill Road bridge on the west side of the Colville River Valley and downstream of the Stimson Lumber Company mill. Water is pumped from the river by the timber mill to wet log decks. A detention pond is used to prevent runoff water from direct return to the river.

River substrate in the reach is a mixture of course and fine material. Just upstream of the site is a large gravel bar formed by the higher energy flow of the Little Pend Oreille River meeting the lower energy flow of the Colville River. The Colville River is braided around the bar and vegetation is growing on it.

The land adjacent to the river upstream and downstream of the site supports industrial, residential, and agricultural land-uses. Arden Hill Road climbs away from the river at a steep grade and is heavily sanded in the winter.

The Colville River at Arden Hill Road drains 751 square miles of land. This accounts for about 74% of the Colville River watershed. Evergreen forest (75%) is the predominant land-cover in the sub-watershed, followed by transitional areas (6.7%), pasture/hay (5.6%), and grasslands (2.8%).

HAL 19: Haller Creek off Skidmore Road – Lat:48.4683 Long:117.9010

Access to the sample site is from the 90-degree corner on Skidmore Road, through private property. The area immediately upstream of the site has residences and is used for agricultural purposes. A historic gaging station was located upstream of the sample site where Skidmore Road crosses the creek. The gaging station was active from August 1959 to September 1970.

There has been significant construction of new homes in the watershed. A subdivision of larger homes was developed in the 1980's along Haller Creek Road. Numerous small animal keeping operations characterize the watershed.

Thirty-eight square miles of land drains to the Haller Creek site off Skidmore Road. This accounts for about 3.7% of the Colville River watershed. Evergreen forest (80%) is the predominant land-cover in the sub-basin, followed by transitional areas (6.1%), pasture/hay (4.9%), and grasslands (3.1%).

CR 20: Colville River at Mantz-Rickey Road, RM 16.4 – Lat:48.5216 Long:117.9098

Upstream of the City of Colville the riparian zone around the sample site contains large, older cottonwood trees. Many of these trees have fallen into the channel both upstream and downstream of the site. Altered flow at the site from debris has caused areas of sediment deposition throughout the channel.

The substrate material is primarily sand, with muck occurring along the west bank in the shadow of large woody debris. Velocities and gradient through the reach are such that deposition of fine materials is occurring.

The land-use immediately upstream and downstream of the sample site is agriculture. Hay and grain crops are raised in the area. The Mantz-Rickey Road, running east west across the valley, is not a heavily used road.

The Colville River at Mantz-Rickey Road drains 800 square miles of land. This accounts for about 79% of the Colville River watershed. Evergreen forest (75%) is the predominant land-cover in the sub-watershed, followed by transitional areas (6.6%), pasture/hay (5.7%), and grasslands (2.9%).

CR 21: Colville River at Oakshot Road, RM 14.3 – Lat:48.5434 Long:117.9308

This sample site is located downstream of the City of Colville's sewage lagoons. Treated wastewater from the lagoons is discharged to the Colville River. The substrate materials are predominantly sand, with some gravel along the west bank. Deposition at the site is apparent by the development of sand mounds. The banks are well covered with grasses but undercutting is evident.

The land-use adjacent to the sampling site is agriculture. Hay and grains are raised and cattle are grazed in the area. Cattle occupy the fields on either side of the site but do not have access to the river.

The Colville River at Oakshot Road drains 817 square miles of land. This accounts for about 81% of the Colville River watershed. Evergreen forest (74%) is the predominant land-cover in the sub-watershed, followed by transitional areas (6.5%), pasture/hay (6.0%), and grasslands (3.0%).

MILL 22: Mill Creek at Highway 395 – Lat:48.5731 Long:117.9441

This sample site is located between the Highway 395 bridge and the Burlington Northern railroad bridge. The channel has changed alignment beneath the bridge, over the years. During periods with multiple channels, samples will be collected upstream of the highway bridge to catch the flow before splitting.

The substrate materials are composed primarily of gravel and cobble. The banks upstream have been stabilized with riprap for a number of years. Some of the large riprap materials are probably native to the site. Velocities in the creek through the sample reach are such that a large amount of material is moved during higher flows.

The Mill Creek drainage contains two very distinct streams, Mill Creek and its tributary, Clugston Creek. Clugston Creek flows into Mill Creek approximately four miles upstream of the confluence of Mill Creek and the Colville River.

The land-use upstream of the sample site include agriculture and residential. Hay and grain, and livestock keeping, characterize the agricultural activities.

The Mill Creek sub-basin is the second largest in the Colville River watershed. One hundred and forty-one square miles of land drain to the Mill Creek at Highway 395 site. This accounts for about 14% of the Colville River watershed. Evergreen forest (82%) is the predominant land-cover in the sub-basin, followed by pasture/hay (4.5%), transitional areas (4.1%), and grasslands (3.4%).

CR 23: Colville River at Gold Creek Road, RM 11.5 – Lat:48.5763 Long:117.9537

The sample site is located adjacent to the Gold Creek Road/Valley Westside Road bridge. The channel is wider at this site. Deeper water is along the riverbanks while deposition has created shallower water mid-channel. Gravel is predominant in the middle of the channel, while boulders are found along the margins.

This site is downstream of the City of Colville and the Vaagen Brothers Lumber Mill. Most of the area between Colville and the sample site is used for agriculture. Hay and grain crops are raised in the area and cattle are grazed along much of the land adjacent to the river.

Downstream of the site is a heavy equipment yard and a deposition site for mining residue. The exact nature of the residue is not known.

The Colville River at Gold Creek Road drains 973 square miles of land. This accounts for about 96% of the Colville River watershed. Evergreen forest (75%) is the predominant land-cover in the sub-watershed, followed by transitional areas (6.1%), pasture/hay (5.9%), and grasslands (3.2%).

CR 24: Colville River at Greenwood Loop Road, RM 9.2 – Lat:48.5887 Long:117.9910

The most downstream sample site for the project is approximately two miles upstream of the backwater effect of the dam at Meyers Falls. The riparian zone in this section of the river contains a substantial amount of large woody vegetation. There is large woody debris upstream and downstream of the sample site but flow does not appear to be affected

Substrate materials are comprised of mixed sand, gravel, and cobble. Flow velocity through the reach is generally high enough to flush much of the fine material out.

The Burlington Northern railroad right-of-way is adjacent to the river at the sample point. The Greenwood Loop Road is paved but not heavily traveled.

The Colville River at Greenwood Loop Road drains 986 square miles of land. This accounts for about 97% of the Colville River watershed. Evergreen forest (75%) is the predominant land-cover in the sub-watershed, followed by transitional areas (6.1%), pasture/hay (5.9%), and grasslands (3.2%).